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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Border Line Alloys.

Scientists have long placed both cast iron and steel in the iron-carbon system, though grey iron has certainly been regarded as a ternary alloy of iron, carbon and silicon. Research on steel has mainly been devoted to the alloyed lower-carbon series (0.25-0.35 per cent.) for structural purposes, and alloyed medium and fairly high carbon steels for cutting tools, but in general the results obtained from truly high-carbon alloy steels have not produced many commercially acceptable developments. Each time a new alloyed cutting steel is discovered, it is associated with a lower carbon content than the pure steel which it has replaced. The meeting place of cast iron and steel is located in practice by the manufacture of wortle or wire drawers' plates. These are of cast-iron composition, yet are slightly forgeable.

The latest developments in cast iron are now almost invariably associated with a lower carbon and silicon content than normal, and cast at as near steel-making temperatures as possible; these may or may not be alloyed. Professor Piwowarsky, in the research presented to the recent meeting of the Institute of British Foundrymen, achieved by the utilisation of these precepts a tensile test of over 47 tons per sq. in. Unfortunately his tests were somewhat vitiated by the presence of pipe in so many of his samples. The insistence of an initially high temperature in the cupola, we feel sure, ought not to be so difficult as the majority of foundrymen would believe. If it is possible in a natural-draught furnace to melt (with difficulty) Swedish bar iron, then surely regarding the cupola as a forced-draught furnace, equivalent if not superior temperatures should be attainable. It should be a *sine quâ non* that no cooling is effected by the blast. In the crucible furnace the air is admitted by means of a bottom grate, and, whilst this is difficult if not impossible of reproduction, limited imitation suggests itself as a reasonable method of approaching this interesting, and not insoluble, problem.

The introduction of alloys is an interesting development in cast-iron metallurgy, but as cast iron can scarcely be expected to compete with steel, the cost of any additions should be kept sufficiently low to ensure that the cost margin between the two materials is wide enough to be attractive to the buyer.

Naturally, the object to be sought is the production of a rapidly malleabilised material, which would show tests analogous to mild steel, but if really high-casting temperatures are an essential, then the lower moulding costs to be associated with cast iron are to disappear, whilst an increase in the waster bill can be confidently expected. Foundrymen, however, must not be deterred by the obvious difficulties. The newer materials are beginning to show but little similarity to what has for years been turned out by a country jobbing foundry, and it does appear necessary to find more apt appellations for modern high-grade cast-irons. The names which so far have been adopted for them in commerce are definitely poor and sometimes quite inappropriate. The foundry apparently has the choice of either bamboozling or educating the engineer's buyer, and we often think, of these, the former is the easier.

World's Largest Winding Engine.

Under the auspices of the Scottish Branch a visit was recently paid to the works of Messrs. Fullerton, Hodgart & Barclay, Limited, Paisley.

The party, which numbered about 75, was met by Mr. John A. Balderston, one of the directors of the firm, who conducted them round the machine shop, fitting shop, foundry, etc.

The most interesting item—and the special object of the visit—was a large electrically-driven winding engine, which the firm are supplying to the City Deep Mines, South Africa. Fig. 1 shows the winder fully completed, and Fig. 2 shows it partially dismantled, the latter one showing the internal construction more clearly.

This winding engine is the largest of its kind in the world, and is designed to raise 9¼ tons of ore from a depth of 4,500 ft. at the rate of 31 winds per hour, the winding speed being rather more than 60 ft. per second.

The drums, which are of the bi-cylindro-conical type, are built up of cast-steel segments, are 17 ft. to 35 ft. in diameter, and are directly coupled through the drum shaft to a motor at either end. The two drums weigh 350 tons, and the rope, which is 2¼ in. diameter, weighs 18 tons.

The main shaft is of hollow forged steel type, finished complete with two motor shafts bolted together, the particulars of the shaft being:—Overall length, 84 ft. 6 in.; external diameters, 22 ins. to 42 ins.; internal diameters, 8 ins. to 18 ins.; and weight complete, 92 tons.

The main motors for driving the drum are 20 ft. in diameter, and when running at the full load speed of 327 r.p.m., are capable of dealing with a peak load of 9,240 h.p. The weight of the two motors is 300 tons.

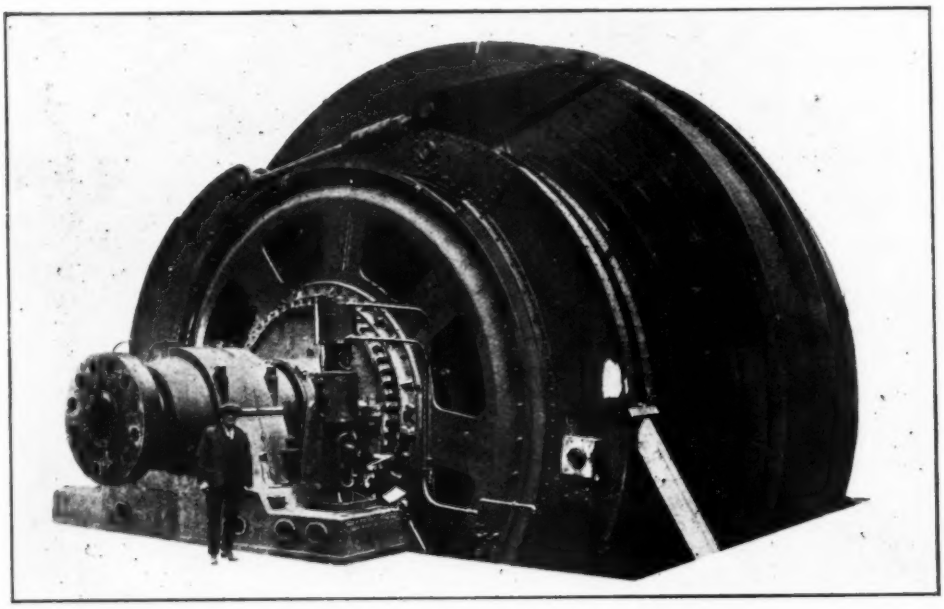

FIG. 1.—THE WINDING ENGINE COMPLETELY ERECTED.

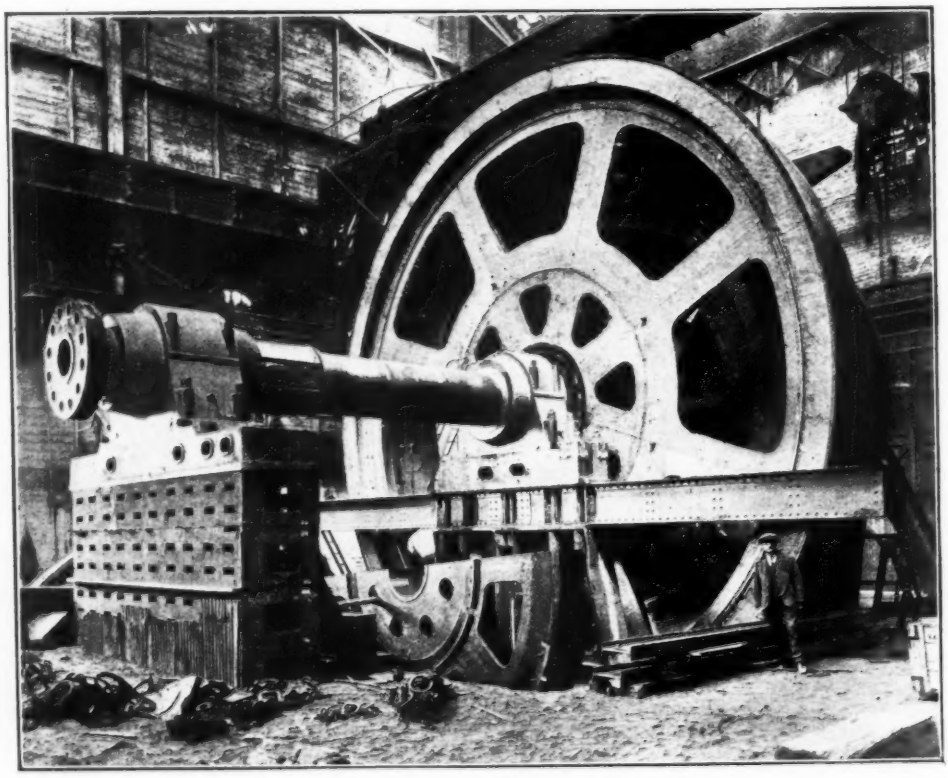

FIG. 2.—THE ENGINE PARTIALLY DISMANTLED.

INSTITUTE OF BRITISH FOUNDRYMEN.

TWENTY-FOURTH ANNUAL CONVENTION.

(*Continued from page* 36.)

The election of officers having been completed, Mr. Faulkner called upon the newly-elected president to address the meeting. Mr. Goodwin, he said, as manager of a large group of pipe foundries, was in a position to voice the opinions of a very important section of the foundry industry.

Presidential Address.

Mr. Goodwin then delivered his presidential address, in the course of which he said,

Mr. Faulkner and Gentlemen:

I have the greatest pleasure in welcoming you all to this great city of Sheffield, the centre of the steel industry of this country. On the occasion of your last visit, nine years ago, we were busily engaged in the production of munitions of war in such quantities as made Sheffield the largest arsenal in the country. Since that time we have, in order to meet present requirements, reconstructed our shops, changed our methods of steel manufacture, and produced new classes of goods of such quality and price as to make our competitors as much afraid of us as were our enemies during the terrible years of the war.

Let me now express to you the deep appreciation I feel at the honour you have accorded me in electing me as your President. When I first joined our Institute, then the British Foundrymen's Association, twenty-two years ago, I little anticipated that I should one day be called upon to fill this important office. Later during your visit to Middlesbrough, in 1907, I came into close touch with the work the Council was doing, and was able to appreciate in some measure the responsibilities devolving on the President in guiding the activities of the Institute, and had the possibility of undertaking those duties been presented to my mind it would have appeared remote.

The Work of the B.C.I.R.A.

Perusal of the addresses delivered year by year by successive Presidents impresses me with the desire revealed therein to express the voice of the members as a whole, and with the possibilities which present themselves to the minds of the most far-seeing among our number. The Presidential address offers a very desirable annual opportunity of reviewing the immediate past and the requirements of the present, and of stimulating thought among members on lines likely to lead to necessary courses of action. Nothing in these addresses has impressed me more than the desire expressed for greater technical knowledge of the craft with which we are so closely associated. I was convinced that when the time was ripe the Institute would embark on a scheme for the systematic acquisition of this technical knowledge, and for the advancement of fundamental research. I had made up my mind that when the time arrived I would give all the help within my power to assist in the promotion of this project. In 1921 the opportunity arose, and I am proud to have been associated with those members whose combined efforts have so successfully brought into being the British Cast Iron Research Association, and who have thus fulfilled the desire expressed by you through successive Presidents. This came none too soon. A new organisation takes time and patience to establish, and this particularly applies to one established for undertaking research work. The difficulties to be met have been numerous. Contemplated under very auspicious trade conditions, the new Association actually started as the disastrous slump of 1921 was setting in. From the effects of this the iron and steel industry has not yet recovered, for while consideration of pig-iron and steel output statistics will show that the situation is now as favourable as at any time since then, there is, of course, still an inadequate margin between manufacturing costs and selling prices.

Nevertheless, I repeat that the formation of the British Cast Iron Research Association came none too soon. On every hand we have proof of extensive developments in research on cast iron not only in the United States of America, where industrial conditions are very good, but equally on the Continent, particularly in Germany, Belgium and France, where trade conditions are not dissimilar from our own. Far-reaching results have been obtained, and are being put into practical use in their foundries. A new organisation in this country was necessary not only to ensure that results of work published abroad could be made available here, but also to initiate research work of our own on British irons, melted in cupolas of our type with the fuel and refractory materials we have daily to use.

It is not necessary for those of us who are in the Association to state what measure of success it has achieved. This, fortunately for our modesty, has been done by an impartial authority in the form of an expert committee set up by H.M. Government in 1926. The extent of the appreciation by the Government of the work done is shown by the generous financial support which has been promised during the period 1926-31. This support is conditional on a better response from the industry than is at present being made, and it remains for you to bring your foundries into the co-operative scheme and to undertake to support the Research Association, which is successfully carrying out investigations the results of which are so important to the future of the founding industry. The annual subscription is small enough to be regarded as little more than an insurance premium, and those who wait for a personal approach before joining are seriously prejudicing the whole scheme, particularly in view of the time involved in making such an approach to all founders concerned.

We believe that membership is a matter of business sagacity, for not only does it help on an important national work, but it offers such opportunities of securing information and assistance as to make it a thorough business proposition.

I estimate that the industry could expend, with advantage to itself, and at an annual cost per firm which amounts, as I suggested above, to little more than an insurance premium, a sum of £25,000 per annum. At present one-third of this sum is available, half of which comes from the industry. For the next four years at least we shall continue to have the Government grant. Furthermore, now that the organisation is built up, for every £1 subscribed, £2 can be expended directly on work of assistance to members.

Apprenticeship Recruitment.

The inevitable growth of technical knowledge in the trade will call for men of higher intelligence and skill, and we must prepare to train our apprentices so that they may be ready to fill these positions in due course. Nothing at the moment is harder to fill than a senior position demanding a man with actual practical experience and technical knowledge. Men with this dual qualification have somehow to be produced, and this Institute must take a large part in their training.

Apprentices who show exceptional ability to absorb technical knowledge and to use it in a practical way should be given opportunities to attend *day* technical classes as well as evening schools, for foundry work is fatiguing. A special member of the staff with suitable qualifications should be detailed off to spend, say, an hour each day with the apprentices, instructing them in the correct way to make moulds and castings. Surely this is not impossible even in these days of bad trade and low prices.

We must also encourage to the full the young foreman by giving him opportunities of seeing other works and other methods. He can be encouraged to use a library by being made an associate member of the Research Association. He

should be encouraged to experiment and to find out which are the best as distinct from the cheapest materials. An occasional monetary recognition of good work when justified will also be a welcome encouragement.

The shortage of boys entering the trade can be dealt with in various ways. The lack of interest shown is often due to lack of knowledge, and the foremen and men in the shops can do much to encourage their schoolboy sons and their chums to visit the foundry. They will talk about it to their respective mothers and thus the industry may secure useful recruits.

I feel convinced that the Institute has a great part to play in educational developments, and in the not distant future an educational scheme may be worked out. Working in the foundry is often considered a dirty occupation, although it is infinitely to be preferred to certain other occupations which on the surface appear much cleaner. In other trades of a similar character, of which coalmining is an example, the trouble has been met by providing washing accommodation and baths. Recreative facilities and opportunities for further education have also been provided. In the foundry we can do much in the way of better accommodation for clothes, for washing, etc., but even more important are working conditions. Special attention should be given to ventilation, so that it can be regulated to suit climatic conditions. When moulds are dried in the shop, either with open fires or portable furnaces, ventilation must be studied with still greater care. Lighting is also vitally important, and roof lights should be provided with means of easy access for cleaning. A works messroom and canteen is essential, and it should be a rule of the organisation that men who do not go home for meals should use the messroom, or at any rate that they should not take meals in the shop. Space will not permit me to mention other ways of improving the general standard of working conditions, often at very little expense. The question of works accidents deserves notice. Every foundry should encourage the men to join the St. John Ambulance Brigade, and to qualify themselves to attend to accidents. A great deal of unnecessary suffering is avoided by prompt attention to cases, even minor cases, which may become septic. Apart from the desirability of all cases having immediate attention, a matter about which the employee concerned is often careless, complications and possibly compensation cases are avoided.

Meeting Competition by Co-operation.

We have seen recently that the only way to maintain the standard of living in this country is, with the goodwill of the men in the shops, to increase output, and we have learned particularly that an increase in output reduces prices, stimulates demand and hence employment, and thus makes things better all round instead of diminishing the amount of work to be done and causing unemployment. In the foundry this means invariably the introduction of piece-work or contract work, which will have in turn the effect of specialising the foundry and thus centralising the production of a given article in a few foundries.

I would appeal especially, therefore, to those members who are practical men in and about the foundry to consider it their duty to do their utmost to enable their employers to meet competition and thus provide that continuity of employment which is so essential to both employer and employed. This continuity of employment is of great importance to the Institute, for the constant migration of members from one shop to another inevitably results in a number being lost to membership, doubtless owing to the feeling of uncertainty which accompanies a change of this kind. Apart from this the rate of growth has doubtless been lessened on account of the continuance of bad trade. The membership of the Institute in 1919 was 1,544, and the average for the last five years has been 1,567. The membership for 1927 shows a decided increase, and the number now totals 1,636. Similar conditions have applied to the Cast Iron Research Association. In 1921 the number of ordinary full members was 110, and in 1927 is 210, representing many more employees, and but for the conditions mentioned would have been much greater. Now that the period of stagnation appears to have passed, it behoves all of us to consider a plan of campaign to improve the membership of the Institute still further. To this end I make a definite appeal to all members to support me during my presidential year by each pledging himself to obtain one new member. With the enthusiasm which exists I feel confident that this can be done. We should then have a membership which the Institute would be proud of, and funds with which to carry on its work with greater activity. I might mention, for instance, the Junior Sections, which have been so ably formed and which are in such a flourishing condition. I am sure that these are a guarantee for the future existence of the Institute, and I wish that more such sections could be formed.

Rationalisation.

An important development which I commend to your earnest attention is the movement spread with remarkable rapidity in Europe under the name of "rationalisation." Summarised "rationalisation," literally the making of industry right and reasonable, aims at securing the highest efficiency for the least effort, at eliminating all waste of raw materials, effort and labour in manufacture, transport and distribution, at simplifying designs, patterns, shapes and sizes where variations have no obvious advantage. It will ensure a higher standard of living, lower prices to the consumers and a larger and more certain return to the producers. It involves the goodwill and willing co-operation of employer and employee and joint efforts of scientific and technical institutions and research organisations. It has to be applied and can equally be applied to large and small undertakings, even to the small shopkeeper and to our domestic life. It means for the worker the healthiest, best and most dignified form of labour, for it involves selection for occupations, proper training and also promotion for those fitted for it, and for all the most attractive form of remuneration.

International Relations.

The work of the Institute is being fully appreciated by kindred organisations abroad. We are honoured this year by the award to one of our most esteemed members of a very signal honour. I refer to the John A. Penton medal, presented by the American Foundrymen's Association to Mr. John Shaw, to whom we offer our sincere congratulations.

The strengthening of ties with our friends abroad has always been the desire of the Institute. Through the good work done by your past-President, Mr. V. C. Faulkner, an International Relations Committee has been formed representing Belgium, Czecho-Slovakia, France, Germany, Great Britain, Holland, and the United States. The object of this Committee will be to promote interchange of papers and visits, to prevent overlapping of conferences and exhibitions, and to make arrangements with respect to periodical international conferences to which the members of all the co-operating bodies will be invited. The formation of this Committee has our cordial support, and we trust that it will go far to cement the friendship which already exists between the allied bodies abroad and ourselves. Your General Secretary is acting as honorary secretary to this new body, and in his capable hands the smooth working of the Committee will be assured. The Institute may reflect with pride on the fact that its international relations are probably more extensive than those of any other technical institute in this country, and there is no need for me to emphasise the important part this plays in promoting international understanding.

To attempt fully to review the work of the Institute for the past year in so short a space as is offered by a presidential address would be folly. I should, however, like to refer to one outstanding feature that I know to have been greatly appreciated, namely, the growing number of invitations extended to the Branch members to visit various works and foundries throughout the country. Neither the educational nor the social value of such visits can be too much stressed. To all those firms who have given us such valuable oppor-

tunities of extending our knowledge, and who have from time to time entertained us so hospitably, the thanks and appreciation of the Institute as a whole are due.

The honour you have paid me implies very great responsibility, of which I am fully aware, and with your loyal assistance I will endeavour to maintain the high traditions of the Institute throughout my presidential year, trusting at the end to see it in still more flourishing condition.

Gentlemen, I thank you.

Vote of Thanks to the President.

MR. J. CAMERON (Past-President), proposing a vote of thanks to the President for his Address, emphasised how keenly Mr. Goodwin had at heart the interests of the Institute and of the British Cast Iron Research Association. Mr. Goodwin was keen on making progress and finding out new things, and if every member took his words to heart and brought in one new member it would be a very fitting reward to Mr. Goodwin for his excellent Address.

MR. A. HARLEY, seconding, expressed the conviction that the President would carry on the work of the Institute in a very efficient and able manner. The President was determined that during his year of office the Institute would make progress, and it was up to the members to support him whole-heartedly in his mission.

The vote of thanks was accorded with acclamation.

THE PRESIDENT, in a brief response, said he was unable adequately to express his appreciation of the kind remarks which had been made, and the way in which the resolution had been received, but he again assured the members that he would do his utmost to carry on the work of the Institute in a manner which would give satisfaction to everybody.

The reading and discussion of Papers was then proceeded with.

During the afternoon the members visited one or other of the representative works in the Sheffield district.

ANNUAL CONVENTION DINNER.

WEDNESDAY, JULY 6.

There was a gathering of some 300 members and guests at the annual Convention dinner, which was held on Wednesday evening, July 6, at the Royal Victoria Hotel, Sheffield. The President was in the chair, and the guests included the Lord Mayor (Alderman J. G. Graves, J.P.) and the Mayoress, the Master and Mistress Cutler (Mr. and Mrs. David Flather), Mr. W. L. Hichens, Mr. A. J. Blanchard, J.P., Sir W. H. Hadow, C.B.E. (Vice-Chancellor of the University), the Mayor of Rotherham, the Mayor of Chesterfield, Mr. Barrington Hooper, C.B.E., Prof. T. Turner, Mr. W. B. M. Jackson, Mr. J. A. Penton (Past-President, American Foundrymen's Association), Mr. E. J. Fox, Mr. J. Smith, J.P., Prof. C. H. Desch, D.Sc., Ph.D. (Professor of Metallurgy, Sheffield University), Mr. J. M. Allan, Mr. F. W. Bridges, Mr. Ropsy (Belgium), Dr. and Mrs. Piwowarsky and Herr Nipper (Germany), Mr. J. H. Monypenny, Mr. John Oakley, J.P., Mr. H. E. Yerbury, and Mr. T. P. Colclough, M.Sc.

Future of Sheffield's Industries.

The loyal toast having been duly honoured,

MR. S. H. RUSSELL (Vice-President) proposed the toast of "The City and Commerce of Sheffield," and in the first place expressed appreciation of the kindness and hospitality extended to the Institute by its friends in Sheffield. In a reference to the educational scheme which Sheffield University had launched a few years ago for the benefit of students and apprentices in the foundry trade, he said he hoped that it had flourished, because it was a really good scheme, which had attracted much attention throughout the country, and the Institute was glad to find that Sheffield was so progressive and could organise such a thorough and comprehensive educational scheme. Dealing with the development of Sheffield's industries, he pointed out that, as shown by the handbook which had been prepared for the members of the Institute, one of the largest steelworks in Sheffield, whose pre-war work was almost entirely Government work, had now practically replaced this by commercial work. When he read such names as Vickers, Cammell Laird, Newton Chambers, Edgar Allen, Brown, Firth, Davy, Samuel Osborn, Mappin and Webb, and so on, almost all of which were world-famed, he realised that, just as Sheffield was a leader and pioneer in the past, so Sheffield would again become a leader and a pioneer in the future. He firmly believed that when the present financial stringency, which affected practically the whole world, had passed away, Sheffield would again come into its own. Could one imagine a city which had produced and was still producing the best crucible high-speed steel in the world, and which had developed and still made the best stainless steel in the world, sinking into the background simply because it could not think of anything else to produce? He did not know what Sheffield would bring out of its hat yet, but he was quite sure that it would bring out something good very shortly. In a tribute to Mr. John Shaw, to whom he referred as a typical example of the Sheffield ironfounder, he said, amid laughter, that during his visit last year to America as a member of the delegation from this country Mr. Shaw had been so keen on visiting works that he had visited a works on one day, travelled all night, and visited another next morning. Continuing, Mr. Russell said that the great essential to the return of prosperity to the iron and steel trades was peace in industry, and he urged that that peace must be a just peace. The industry had a very big problem to face. Finally, he coupled with the toast the names of the Lord Mayor and the Master Cutler.

Sheffield Now Making Fine Iron Castings.

THE LORD MAYOR, in his response, said that a Lord Mayor of Sheffield always felt considerable pride when replying to this toast. He had a good deal of practice, but that in no way detracted from the pride which he felt in representing this great community, for they had not only a past of which they were unreservedly proud, but a vigorous present, and a hopeful outlook for the future. No city in the world had had a harder job to deal with than had Sheffield during the past few years. The difficulties had been formidable and the ordeal severe, but they were emerging and were feeling solid ground under their feet. They had drawn, as they had had to do, upon their reserves of inventiveness, enterprise, self-reliance, pluck and perseverance, and their great industries had adapted themselves in a way which he could only describe—knowing what he did of the conditions of the past six or seven years—as surprising and marvellous. The Institute's own handbook contained a very generous, but perfectly just, appreciation of the inventive ability, enterprise and leadership of the men who had founded Sheffield's great industries, and whose great names were still the signs of firms of world-wide reputation, and all that had been said of them could be said with equal truth and justice of their successors to-day. To Sheffield's workmen, also, the Institute had paid a just tribute. It had said that the Sheffield worker was a craftsman, and experienced non-technical men had shown uncanny knowledge of the steel which they produced, which would shame distinguished academics. He thanked the Institute for its generous appreciation, and for the great compliment it had paid to Sheffield in choosing the city as the meeting-place on this occasion. In a reference to post-war progress in Sheffield, in the course of which he dwelt upon the Corporation's efforts in regard to town planning, and the provision of houses, roads, transport, etc., he said that the foundry branch of the great iron and steel industry had shown versatility, adaptability and enterprise beyond all praise. For example, the progress made in the production of fine castings had come particularly under his notice in connection with his own business. He believed he could say that in pre-war days the Sheffield founders were not No. 1 in the production of extremely fine castings, and when it had become necessary to look around for new sources of supply, those who needed such castings had met with great difficulty. But, instead of going to sleep about it, the Sheffield founders had met their competitors on their own ground, and

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were now not only producing the equal of the fine castings which for some businesses it had been necessary to import, but had excelled their competitors. He was very pleased and thankful to recognise the international note which had been sounded at this conference. It was to him a matter of the greatest satisfaction to know that there were attending the Conference representatives of the progressive nations of Europe. Sad and painful as were the memories of the past few years, to-day our faces were turned towards the morning once more, and we looked to a better world, to safer, sounder and saner foundations of society than those which had resulted in the shocking catastrophe which we all lamented, and which had so disorganised industry. Great Britain showed how, in one small area, three nations could live together in peace, harmony and helpfulness. As another example he mentioned that along the 3,000 miles of frontier separating the United States and Canada there was not a soldier or a fort. Why should there not be in the future, through the medium of organisations such as the I.B.F., the United States of Europe? What we were longing for was peace in our industrial relations. That would not come through Acts of Parliament; it would come only when each of us did our bit towards it, and we had better not shirk the responsibility. There rested upon each one of us the responsibility to do our part in the building up of a better, safer and a more enlightened society. Finally, the Lord Mayor expressed his earnest and heartiest wishes for the continued success of the Institute.

Multiplicity of Technical Associations.

THE MASTER CUTLER, who also responded to the Toast, expressed the very real pleasure which it gave Sheffield to welcome the members of the Institute to the city. They might have a lot of smoke in Sheffield, but not so much as they would like. It was an old saying in Sheffield that "Where there is muck there is money," but they always added "provided it is clean muck." They were not doing enough business, but hoped and believed that the time would come when that deficiency was made good and when they would again flourish and would be able to look the world in the face. Sheffield undoubtedly had played a very great part in the advance of the iron and steel and many other industries and it was proud of that fact; it was proud that it had been able to help, on the technical and scientific side, so many trades and industries in this country. After a reference to the valuable work of the Sheffield University, he said there was another phase of knowledge leading to prosperity which even Universities could not give. By that he meant that only through the association of men who were interested in any particular subject could real progress be made. From the early days of, he believed, the seventeenth century, when the Royal Society was founded, men began to realise that only by combination, by mutual trust and help, could the truth be discovered and knowledge acquired, and as the centuries had rolled on the number of those associations had greatly and steadily increased. It might be that to-day we had too many associations, but the great point about technical associations was that they led men to know one another and to have trust and confidence in their fellows, and although individually they might be competing for the necessities as well as for some little of the luxuries of life their association together was bound to create good in industry, and in municipal, social and national life. Associations such as the I.B.F. tended to promote prosperity and to stabilise our industries. He would to Heaven that that spirit of mutual helpfulness was greater and he prayed that the time might come when the spirit of evil which led men to suspect their fellows of some ulterior motive would be cast out and when we should unite with the common object of improving the relations between man and man, between nation and nation, and when there would be in truth a United States of Europe. In the name of Sheffield and those engaged in its industries he expressed to the Institute the heartiest welcome, congratulated it upon the splendid work it had already done and hoped that it would prosper, to the advantage of its individual members, the Institute itself and to the advantage of the Empire.

How Technical Societies Help Their Members.

MR. W. L. HICHENS (Managing Director of Messrs. Cammell Laird & Company Limited), proposing the Institute of British Foundrymen, emphasised the national importance of the steel industry, of which the foundry trade was an important part. If the steel industry languished, he said, Great Britain would surely languish too, and it was to the interest of everybody to see that not only should the steel industry maintain its previous strength, but that it should increase it and become even greater in the future than it had been in the past. The steel industry had suffered considerable misfortune during the past few years. It had laboured under great difficulties; competition had been very fierce, work had been scarce, prices had been cut to the point which had dismayed all those engaged in the industry, and had delighted correspondingly all those who were not. They were not merely confronted with domestic competition and low prices emanating from a domestic source. They found that foreign competition was even more strenuous, and he believed that as regards foundry work foreign competition was as keen as in any other industry, and prices quoted by foreigners at the present time were sometimes so low as to cause dismay. He was quite convinced, however, that the steel industry could be restored to its former prosperity. Enumerating some of the great benefits which the I.B.F. could and did confer upon the foundry business, he said that in the first place the Institute as he saw it stood for solidarity and good fellowship among all those engaged in this great profession. Solidarity and friendship meant, he supposed, that if A discovered something which was of interest to the industry as a whole, he communicated it at once to B, C, D and the rest; but did he? No! He kept it to himself in the hope that no one else would find it out, and in so acting he behaved very foolishly, because each of us had ways and means, which we thought peculiar to ourselves, but which were in reality common to all, for discovering what he was up to. Therefore, it would really be wiser if A communicated straight away what he had found out instead of allowing everybody to exercise his ingenuity to discover it by devious ways instead of devoting his ingenuity to other and better purposes. Again, solidarity and good friendship meant that if B got into trouble he went to A or to some other who was not in trouble and asked for help to get out of it. But did he go to A or to some other and confess that he was in a hole? Not a bit of it. Therein he acted foolishly, because everybody found out that he was in a bit of a mess—and in the steel industry, from his own experience, everybody got into a mess at times. In such circumstances as he had indicated, B pretended that he was not in a mess at all, everybody else exaggerated the tittle tattle they heard all around, and the gossip was far worse for B than the truth. But supposing that when he got into a mess he did confide his troubles to A, what would A do? He doubted if A would do more than say that in that case B would have to be contented with his heart-felt sympathy. Probably it would not go farther than that. That was a pity, because British A, B and C were not really rivals the one of the other. They were much more the rivals of a foreign X, Y and Z, and what mattered for this country from the broad point of view was that our industry as a whole should be as efficient as possible, and that the weakest member, if there be a weakest member, should be helped by the stronger member so that as a whole we could be strong enough to stand up against foreign competition and that by a united knowledge and competition we should be able to face the strenuous opposition we were met with abroad to-day. He knew that he was regarded as a visionary, but he was quite unrepentant. He always asked for more than he expected to get and perhaps he had done that on this occasion, but surely we should do something more than we had done. For instance, we might, he con-

sidered, without the world coming to an end, allow each other freely to visit our works. That would not be going so very far. We might, for instance, compare costs. That was going a little further, but it was the right thing to do if we wanted to have a nationally efficient industry and not an individually efficient industry. We might compare methods with great advantage, and that was one of the directions in which he wished the Institute every success because it stood for the right thing.

Foreign Contacts.

There was another respect in which the Institute could and did perform a great service to the industry, namely, in the promotion of contact with our foreign competitors. He was glad to notice that a number of valuable papers by foreign experts had been read at the meeting and to know that foreign representatives were attending the Conference. That was the right thing because although he felt that in a sense the British were the rivals of the foreigners, yet in a wider and bigger sense they were comrades on the same quest, *i.e.*, the quest of the greatest efficiency in the steel industry for the sake of the whole world, and that was an ideal which was worth something. The Institute had done a great deal also in promoting tours and visits to works in other countries which was most valuable to this country, and, he hoped, useful to the countries visited, and he trusted that the Institute would be able to extend that. Discussing finally the development of education, he said there was a time—he did not know whether it had altogether gone by—when people used to say that foundry work was a rough kind of work and therefore it was not the kind of work that an educated man was likely to do. That was all wrong, for all experience went to show that the steel industry was becoming more and more dependent upon science, and the more we could attract men of eminent scientific attainments to take up work in our foundries and in the steel industry as a whole, the better it would be. But that was not all. It was even more important that we should encourage education among apprentices in the foundry business. He could not help believing that one of the great advantages that the Americans and Germans had over us in industry was that there was such a high standard of education in those countries amongst men engaged in industry. Finally, Mr. Hichens paid a tribute to Mr. Goodwin, whose valuable work was recognised and whose year of office would add lustre to the Institute of which he was so distinguished a President.

Results Achieved by the Institute.

The PRESIDENT responded, and, in thanking Mr. Hichens for the manner in which he had proposed the toast, said that the members of the Institute who had visited the works of Messrs. Cammell Laird & Company that day had been very much impressed with the great changes which had been made to meet present-day competition. The re-organisation of those works seemed to him to be the greatest monument to industry that he had seen lately. Not only was it apparent that the staff had worked exceptionally hard, but also that what had been effected was the result of round-table co-operation. The happy feeling which he had recognised among the staff of Messrs. Cammell Laird twenty years ago, when he had first visited their works, still existed, and had brought about the alteration of the works which everyone was so gratified to see. Referring to the Institute, he was happy to say that it was on the fringe of the work which Mr. Hichens had outlined. One result was the formation of the International Committee, in connection with which the immediate Past-President, Mr. Faulkner, had been to the Continent, and had worked very hard indeed on behalf of the Institute to cement that friendship with other countries which they all so much desired, and which they knew would be ultimately to the good of everybody in this country. He was also pleased to be able to tell Mr. Hichens that the friendship amongst the foundrymen of this country, to which reference had also been made, did exist. Barriers were being broken down yearly by the Institute, and nothing but good could result. The President then went on to deal with the development of the Institute since it was founded in 1904, at Birmingham, when the late Mr. R. Buchanan was elected President. Since that time the Institute had held Conventions in most of the large cities of the country, and the last Convention in Sheffield was held in 1918, under the Presidency of the late Mr. T. H. Firth. With regard to membership, he said that as the foundry trade was one that had suffered the most during the last five years of trade depression, it would be understood that membership had not increased as rapidly as had been hoped. However, from past experience it was found that as soon as there was the least improvement in trade the Institute obtained an increase in membership. At the moment the number was low in comparison, namely, 1,700. At the same time, one must not overlook the fact that the Institute now had an offshoot in the form of the British Cast Iron Research Association, the membership of which included a number of the Institute's members, and also that there were a number of would-be members who could not afford to be members of both. The 1,700 included trade members, each of whom represented a large number of employees, so that the information the Institute was able to send out was transmitted to a larger number than 1,700. In a reference to the ten branches, all of which were in a flourishing condition, he made special mention of the manner in which the London Branch had worked, as the result of which it had nearly doubled its membership. He did not know of any Institute which arranged for so many works visits as did the I.B.F., and he believed the Institute was doing more educational work amongst the practical men in the foundry than any other body was doing in a like manner for the membership represented. The junior sections of the Branches were also in a most flourishing condition, and it would be appreciated that the members of these junior sections would be the backbone of the Institute in the future. In regard to the Institute's charter, he was pleased to say that Sheffield had figured largely in obtaining it; it was due to the indefatigable energy and generosity of the late Mr. T. H. Firth that the Institute had become a chartered Institute.

The Cast Iron Research Association.

The formation of the British Cast Iron Research Association by members of the Institute was another matter to which the President referred. The programme before that Association, he said, was such that it would necessitate the expenditure of not less than £8,000 per year, to which the Government were contributing approximately 30 per cent. The Association had been formed in most difficult times, but it was in times such as these, when trade was bad and foreign competition was keen, that research work of the kind that the Association had undertaken was most needed. Unfortunately, also, it was at times such as these that an employer was least able and most unwilling to pursue them. Nevertheless, the Association was being favourably supported, not only by employers, who were fully alive to the fact that on every hand we had proof of extensive developments in research in cast iron abroad—in the United States, where trade had been good, and on the Continent, where conditions of trade were similar to our own—but also by employees, who were anxious that England should continue to produce "more perfect work, more finished work, more honest work, than any other nation in the world." He felt that good trade was coming. From past experience he knew that this meant increased prosperity to the Institute, both financially and numerically, and in order to maintain our trade he urged the adoption of the slogan, "All-British goods for British people," and support for the good work done by the greatest commercial travellers this country had ever known, and of whom we were so justly proud—the Prince of Wales and the Duke and Duchess of York.

MR. OLIVER STUBBS (Past-President), in the absence of Sir Robert Hadfield, Bart., F.R.S., who was unable to attend, and who had conveyed by telegram his good wishes for the success of the Conference, proposed "Our Guests and Kindred Associations." After expressing gratitude for

the kind reception which Sheffield had accorded the members, he said the members were proud of the Institute because it was the only body which took a man out of the shop and brought him among others connected with the industry. In welcoming the Institute's guests from abroad, he emphasised that the more closely we were able to co-operate with those other countries the better should we be able to establish and maintain industrial peace. He coupled with the toast the name of Mr. J. A. Penton (Past-President of the American Foundrymen's Association).

Anglo-American Relations.

MR. J. A. PENTON, responding, said that although his visit to this country was partly a personal one, he had been anxious to pay his respects to this wonderful Institute of British Foundrymen. Americans, he said, were very deeply concerned with regard to the position of the iron and steel business in Europe, and not for selfish reasons. America was a prosperous nation, and there was market enough in their own country—the home market constituted over 90 per cent. of their business—without going abroad. They were deeply concerned sentimentally regarding the conditions of the iron and steel industry in Europe, and they realised fully the terrible strain that had been put upon all the nations of Europe in connection with the war, which had profited none, but had meant great loss to all. They considered that the greatest accomplishment and the greatest victory of the whole war was that of the nation which, beset with a great debt and heavy taxation, had put its currency on par. Americans took their hats off and bowed their heads to that nation for having made a serious effort to get on to her feet. Emphasising the importance of constant contact as a means of preserving peace between the nations, he said that the excellent relations which existed between the United States and Canada, with their contiguous frontiers, was largely due to the fact that they spoke the same language and knew each other as the result of constant association. Industrial peace was all very well, but international peace was a more vital factor. The one great power and the greatest influence of all in preventing conflicts in the future would be an affiliation between the English-speaking peoples of the world such as there was between Canada and the United States. These thoughts were also those of a great multitude of thinkers in his own country. He felt that the time was not far distant when the United States and Great Britain should so understand themselves and each other that they would both agree to march step by step for ever to the music of a band playing "Peace on earth and good will to men."

MR. V. C. FAULKNER (Past-President) proposed the toast of "The University of Sheffield." Owing to the late hour he curtailed his speech considerably, but he did take the opportunity to compliment the University authorities upon their astuteness and broadmindedness. He coupled with the toast the name of Sir Henry Hadow (the Vice-Chancellor).

Prizes for Practical Discovery.

SIR HENRY HADOW (Vice-Chancellor of the University), who on rising to respond was greeted with enthusiasm, said that the University authorities were very glad indeed to join with the Lord Mayor and the Master Cutler and others in Sheffield in welcoming the Institute on this occasion. He stood, he said, as a representative of education, and education, he was glad to say, was one of the subjects upon which more nonsense was talked than any other in this country. He was glad because it was one of the symptoms of becoming a public institution in England that people should blame, criticise or discuss it when they had not devoted any great attention to the subject. A man who one would not ask to direct one to the Post Office was perfectly prepared to say what this country ought to do about China, but if one asked him if China was in Africa or South America he would shift the conversation to Ireland. (Laughter.) That was exactly what was happening on the topic of education. He was told on all hands and he read in all quarters that there were two kinds of education, the academic and the practical, and that not only had they different kinds of method, but different kinds of truth; that colleges and universities and such-like taught theoretical and truth that would not work out in practice. He was told that practical education was that which dealt with the truth by which people could live and by which they could work—with which the academic principle had nothing to do. There was no greater nonsense in the world than that. If Universities taught academic truth which would not work out in practice they would be merely the depositories of useless knowledge, and the sooner they shut up shop the better. If the members of the I.B.F. and their forbears had always tried to do without theory they would be sitting together that evening enjoying a banquet of raw wild beasts and very imperfectly distilled water. There was no education in the world worth the name which did not comprise both sides and co-ordinate both sides. The University authorities were fully aware of that, and because they were fully aware of it they were particularly glad to welcome the co-operation of those who were engaged on the practical side, who could learn something from the University and from whom in turn the University could learn something. Discussing the importance of pooling information, which had been mentioned by Mr. Hichens, Sir Henry drew attention to the fact that a short time ago the Company of Armourers and Braziers, which had been a very good friend to the University, had devoted an annual sum, which had been presented to the Master Cutler (who had kindly called in the co-operation of the University to administer it) for the purpose of encouraging research in the practical trades of Sheffield, of which the foundry trade was one. Prizes would be given, not on literary merit, but on practical discovery, and would be open to all workmen and members of the trade, and the prize-winning Papers would, if of sufficient merit, be printed and circulated for the common use. That was a very important step in the direction of that general co-operation which Mr. Hichens had so strongly desiderated. Referring to the advantages of providing facilities for visits to works, he recalled a conversation he had had with the head of one of the Great American firms some time ago whilst crossing the Atlantic. The American had told him that one of the principles which had always inspired and animated his work was to allow all his competitors entirely free access to his works, to show them everything, to explain everything and keep nothing back. When he (Sir Henry) had replied that other people to whom he had spoken on the subject had expressed misgivings and had said that possibly others might take away their secrets and use them to their detriment, the American had reflected for a moment, and he replied, "That's silly." That, continued Sir Henry, was a man with a life-long experience in the matter, and who knew what he was talking about. It had very much impressed him (Sir Henry), and he passed it on as a word of wisdom which he believed had its real educational value. Finally he paid a tribute to Mr. Faulkner, whom he said the University was proud to have as an old member.

During the evening the members and visitors were each presented with a Sheffield stainless-steel pocket knife as a memento of the Convention. It being remarked by the President that the recipients would probably like to cut their luck, they were invited to contribute towards the funds of the Sheffield Works Convalescent Homes. There was a liberal response, and the proceeds, which amounted to £13 15s., were handed to the Mistress Cutler, who is interested in the homes and who briefly expressed her gratitude.

THURSDAY, JULY 7.

Both morning and afternoon sessions were devoted to the discussion of the papers submitted. During the late afternoon the members attended a civic reception at the Town Hall offered by the Lord Mayor and Corporation. In the evening, at the invitation of the Reception Committee, the members visited a vaudeville show at a local music hall.

FRIDAY, JULY 8.

On the morning of Friday, July 8, parties of members visited each of the following works:—Messrs. Davy Bros., Limited, Darnall; the Brown Firth Research Laboratories; and Messrs. Samuel

Osborn & Company, Limited. At the conclusion of each of the visits the thanks of the Institute were tendered to the respective managements for their courtesy.

At a luncheon held at the Grand Hotel, at which a large number of members and ladies were present, Mr. J. T. Goodwin, the President, presided, and again voiced the thanks of the Institute to the various firms who had permitted the members to inspect their respective works. He particularly referred to the courtesy of Dr. W. H. Hatfield, who had personally conducted a party of members around the Brown Firth Research Laboratories that morning.

In reply, Dr. W. H. Hatfield, Director of the Brown Firth Research Laboratories and Past-President of the Sheffield Branch, expressed the pleasure of his directors and of himself at the opportunity of meeting the members of the Institute. He referred to the rapid growth of the Institute, both in numbers and in influence, and he also stressed the importance of the rapid developments in the metallurgy of cast iron which had taken place in recent years.

Visit to Buxton.

On the afternoon of Friday, July 8, the final event of the Conference took place in the form of a motor excursion through the Derbyshire Dales, a halt being made for dinner at Buxton. About 90 members and ladies participated, and, in spite of the somewhat showery weather, the party had a very enjoyable outing.

Mr. J. T. Goodwin, President of the Institute, presided over the dinner, which was held at the Palace Hotel, Buxton.

After the loyal toast had been honoured, MR. G. H. OXLEY, Vice-President of the Sheffield Branch, proposed the toast of "The Visitors," and referred to the pleasure which the members had in entertaining their guests, particularly those from other countries.

PROF. PIWOWARSKY replied on behalf of the guests, and thanked the members for the very cordial reception which the visitors had received throughout the Conference. He stated that the presence of overseas delegates at Conferences such as this would go far to cement the friendship between the various countries. He concluded by proposing the health of the President, which was drunk with considerable enthusiasm.

The PRESIDENT thanked the company, and referred to the work which had been done by the Sheffield local Committee in organising the Conference. He said that the success of the Conference was largely due to the hard work which had been done during the previous few months by the local Committee, and he also expressed the thanks of the members to the Ladies' Committee, and to their convener, Mrs. Frank Russell, for their work in connection with the ladies' social programme, and for the manner in which they had arranged for the welcome of the lady visitors to the Conference. He said that they were specially indebted to Mr. Firth and Mr. Edginton, respectively Past-President and President of the Sheffield Branch, and also to Mr. W. A. Macdonald, the Convention Secretary. On behalf of the Committee he had pleasure in presenting a fountain pen to Mr. Macdonald as a token of their esteem, and also a wallet of notes to Mrs. Macdonald.

MR. MACDONALD was accorded an enthusiastic reception upon rising to reply. He said that as soon as it became known that the Conference would be held in Sheffield he felt that it was his duty to assist in every possible way, and he had been loyally supported by every member of the Executive Committee and of the Branch Council.

He tendered his thanks to Mr. Makemson, the General Secretary, and his assistant, for the invaluable help which they had rendered. He said that anything which he had been able to do had been done with a good heart, and he hoped that when the members and ladies went back to their own cities and towns they would take with them pleasant memories of the few days they had spent in Sheffield.

Sheffield Convention Visitors.

The following is a list of members who attended the Sheffield Convention:—

F. Allan (Sunderland), A. L. Allford (Sheffield), J. A. Ayres (Sheffield), Major J. W. Athey (West Bromwich).

R. P. Bethell (Walsall), J. H. Booth (Peterborough), F. Batty (Sheffield), J. M. Blair (York), P. T. Bailey (Dronfield), J. Bartram (London), H. Bunting (Derby), H. Bradley (Sheffield), A. S. Beech (London), Dr. M. L. Becker (Manchester), A. Brailsford (Newcastle), F. Biggin (Sheffield), J. Bell (Glasgow), J. Bradbury, J. Bevins (Ulverston).

F. J. Cook (Birmingham), A. Campion (Glasgow), J. Cameron (Kirkintilloch), B. Collins (Sheffield), J. F. Chambers (Chesterfield), H. F. Chope (Sheffield), G. C. Castle (Sheffield), H. F. Coggan (Halifax), E. A. Carlisle, F. J. Cree (Peterborough).

V. Delport (London), J. Davenport (Leyland), H. C. Dews (London), J. Durrans (Penistone), D. Dalrymple (West Bromwich), Professor C. H. Desch (Sheffield).

J. Ellis (London), J. Emmott (Sheffield), A. Edwards (Cheltenham), G. Edginton (Chesterfield), W. T. Evans (Derby), S. Evans (London), J. English.

J. E. Fletcher (Birmingham), B. Fender (Monkseaton), J. L. Firth (Sheffield), Ambrose Firth (Sheffield), L. G. Firth (Sheffield), H. Forrest (Bradford), G. E. France (Halifax), V. C. Faulkner (London).

W. B. Gondielock (Barrow), B. Gale (Nottingham), J. T. Goodwin (Chesterfield), A. G. Griffiths (Birmingham), F. Green (Rotherham), C. Gresty (Monkseaton), F. Gill (Nottingham).

F. H. Hurren (Coventry), A. Harley (Coventry), J. E. Hurst (Thorncliffe), F. A. Harper (Stockton-on-Tees), A. Barrington Hooper (London), F. Hudson (Kilmarnock), R. Hares (Bristol), R. S. Harris (Dronfield), J. Housley (Ipswich), J. Hogg (Burnley), B. Herd (Newport), J. R. Hyde (Sheffield), C. W. Hampton (Sheffield), J. Haigh (Wakefield), G. E. Hider (Torquay), A. S. Hider (Torquay), R. R. Hargreaves (Chorlton), R. C. Hargreaves (Stockport), S. Hadfield (Leicester), Dr. W. H. Hatfield (Sheffield), A. Hodgson (Manchester), S. B. Hole (Wednesbury).

J. W. Jolley (Manchester), J. E. Jadoul (Manchester), Eng.-Commander L. Jackson (Sheffield).

W. T. Kitchen (Sheffield), C. Kessell (Sheffield), E. King (London), J. F. Kayser (Sheffield).

W. B. Lake (Braintree), J. Laing (Bedford), Wesley Lambert (London), R. D. Lawrie (Thorncliffe), M. Loxton (Leeds), C. R. Loxton (Leeds), E. Longden (Manchester), G. Lillie (Durham), J. Lucas (Loughborough), D. C. Lloyd (Wolverhampton), A. Lomas (Sheffield), A. Logan (Newcastle).

W. Machin (Barrow), R. A. Mills (Manchester), H. Mills (Manchester), H. C. Marshall (London), J. E. McGrah (Wolverhampton), T. W. Markland (Bolton), F. A. Melmoth (Sheffield), T. McFarlane (Horsehay), J. Masters (Shrewsbury), T. Makemson (Manchester), D. McPhail (Glasgow), W. A. Macdonald (Sheffield), C. Mace.

The Hon. J. W. M. North (Chesterfield), Dr. A. L. Norbury (Birmingham), J. D. Nicholson (South Shields), E. Northam, F. K. Neath (Birmingham), J. Nield.

G. H. Oxley (Sheffield), G. L. Oxley (Sheffield).

H. Pemberton (Derby), J. A. Penton (Cleveland, Ohio), J. G. Pearce (Birmingham), W. H. Poole (Keighley), C. Presswood (Sheffield), J. S. G. Primrose (Manchester), C. Pollard (Sheffield), H. Phillips (Wednesbury), A. E. Pearce (Derby), T. Packman, J. M. Primrose (Falkirk), Dr. E. Piwowarsky (Aachen).

J. Rodgers (Sheffield), R. H. Ritchie (Middlesbrough), P. Ropsy (Antwerp), J. Riley (Oldham), J. G. Robinson (Halifax), G. E. Roberts (Sheffield), F. Russell (Sheffield), S. H. Russell (Leicester), P. A. Russell (Leicester), N. D. Ridsdale (Middlesbrough), F. O. Robinson (Widnes), J. R. Rodgers (Sheffield), J. Roxburgh (Sheffield), F. Ridmy (Wigan), G. E. Roberts (Coventry).

J. Shaw (Sheffield), V. Stobie (Newcastle), J. L. Smith (Stockton-on-Tees), H. Sherburn (Warrington), G. Stevenson (Nottingham), B. Skidmore (Letchworth), J. Sandford (Sheffield), H. G. Sommerfield (London), H. Simpson (Dawley, Shropshire), A. L. Steggles (Sheffield), T. Singleton (Sheffield), G. Senior (Sheffield), A. Scholes, H. Shillitoe (London), J. N Simm (Monkseaton), A. Sutcliffe (Bolton), F. A. Spiers (Leicester), Oliver Stubbs (Manchester), Roy Stubbs (Manchester),

F. Sanderson (Newcastle), H. L. Simpson (Stamford), F. A. Shirt (Sheffield), J. G. A. Skerl (Sheffield).

G. V. Toy (Saltburn), W. J. Tarrant (Poole), E. R. Taylor (Birmingham), A. C. Turner (London), Professor T. Turner (London), T. H. Turner (Birmingham), H. L. Turner (Walsall).

G. H. Underwood (Chesterfield).

B. Winterton (Chesterfield), D. H. Wood (Birmingham), C. H. V. Wilson (London), R. C. Waddell (Glasgow), F. P. Wilson (Middlesbrough), P. H. Wilson (Stanton), N. F. S. Winter (Halifax), E. A. Wood (Rotherham), C. Webster (Rotherham), A. Whiteley (Sheffield), O. H. Wass (Leeds), J. J. Wares (Peterborough), W. A. Wordsworth (Sheffield), I. Wilkinson (Stockton-on-Tees), H. Winterton (Milngavie), T. Walmsley (Sheffield), E. Whittaker (Bradford), A. L. Worcester (Huddersfield), W. Woodhouse (Stanton).

I.B.F. Elects New Members.

At the last General Council meeting of the Institute of British Foundrymen, held on July 5, the following were elected:—

As a Subscribing Firm.

Messrs. G. R. Cawood & Co., Ltd., 1, Cavendish Road, Leeds.

As Members.

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As Associate Member.

J. I. Clark (Foundry Foreman, Hattersley (Ormskirk) Ltd., Lancs.), 39, Dicconson Street, Ormskirk, Lancs.; J. E. Cooke (Patternmaker, Metropolitan-Vickers Electric Co., Manchester), 116, Derbyshire Avenue, Stretford; W. Martin (Moulder, Metropolitan-Vickers Electric Co., Manchester), 34, St. Georges Road, Withington, Manchester; T. Walmsley (Foreman Patternmaker, Dewhurst's Engineering Co., Ltd., Sheffield), 2, Calder Way, Firth Park, Sheffield; R. Woolen (Chief Assistant Chemist, Sheepbridge Coal & Iron Co., Ltd.), Cowley, Dronfield, near Sheffield; A. S. Hilder (Ironfounder and General Engineer, Upton Foundry, Torquay), Lauriston Villa, Parkfield Road, Torquay; F. E. Hyde (Foreman Moulder, G.W.R. Works, Swindon), 32, Volta Road, Swindon; A. C. Johnson (Journeyman Moulder, Chemical Laboratory, G.W.R. Works, Swindon), 48, Gooch Street, Swindon, Wilts.; H. Balme (Iron Moulder, J. Charlesworth, Ironfounders, Colne Road, Huddersfield), 33, Grange Avenue, Marsden, near Huddersfield; J. Knight (Iron Moulder), 138, Winwick Road, Warrington; Douglas Carver Boulton (Engineer and Foundry Draughtsman, Sheepbridge Coal & Iron Co., Ltd.).

As Associates.

C. H. Connell (Head Furnaceman, Hetherington & Sons, Ltd., Manchester), 15, Rotherwell Street, Salford; L. G. Firth (Apprentice Patternmaker, Brightside Foundry & Engineering Co.), 41, Slayleigh Lane, Fulwood, Sheffield; D. D. Naidu (Assistant to Engineering Works Manager, Sunate E. Hind Engineering Works, Hyderabad, India), 219, Residency Bazaars, Hyderabad, Deccan, India; S. Stanworth (Patternmaker, Vulcan Ironworks, Accrington Road, Burnley), The Woodlands, Rimington, Clitheroe; F. S. Wordsworth (Analyst, Steel Works, Chemist Cyclops Works, Cammell Laird & Co., Ltd.), 11, Coverdale Road, Sheffield.

Merchandise Marks Inquiries.

The Standing Committee (General Merchandise) appointed by the Board of Trade will hold, on Monday, July 25, at 10.30 a.m., their inquiry as to whether the following descriptions of imported iron and steel wire products should bear an indication of origin:—Barbed wire on reels; wire nails and wire staples; wire in coil, including strand wire; baling wire cut and looped at one end, or both.

A further meeting will be held on Tuesday, July 26, if necessary. The inquiry will be held in Room 76, First Floor, New Public Offices, Great George Street, London, S.W.1. Any communication on the subject should be addressed as early as possible to the secretary, Mr. E. W. Reardon, at that address.

Publication Received.

Institution of Mechanical Engineers: Brief Subject, Index of Papers. Published in the Proceeding, 1847, to December, 1926. Storey's Gate, St. James's Park, London, S.W.1.

A book of this character does show up to advantage the unique interest which is to be associated with an old foundation. Naturally we turned up the Index for the papers on Foundry Practice and found that from 1854 to 1868 some half-dozen papers of outstanding interest were presented. Ireland's and Krigar's cupolas were described, whilst other two papers dealt with improved casting methods. We congratulate the Institute on this publication, which has condensed to a handy size all the outstanding papers presented to them over their long and distinguished existence.

MR. G. BRADSHAW, a director of the firm of Turton Brothers & Matthews, Limited, Wentworth Street, Sheffield, died last Friday.

The Strength of Cast Iron.*

By J. E. Fletcher, M.I.Mech.E., Consultant to the British Cast Iron Research Association.

Many foundrymen are unaware of the difficulties experienced by the blast-furnaceman in the production of foundry pig-iron of uniform mechanical strength, in the pig form, even though the chemical analysis be closely similar in the pigs of a particular cast. The number of drops on the pig sampler's anvil necessary to break pigs from different parts of the pig bed may vary considerably, and the fractures may vary correspondingly. The so-called "scattered" fracture has always been a source of anxiety to the blast-furnaceman, and he is perhaps as much at sea to-day as ever in diagnosing the cause of the vari-grained fracture in cast irons of medium silicon content (1.5 to 2.5 per cent.).

It is well known that within this range—which is the one most used by the foundryman—there is the greatest variation in blast-furnace behaviour, the cause being probably complex in character. In trying to avoid the trouble all kinds of methods have been tried, no one of which seems to be universally successful.

In the re-melted pig-iron from this critical range the variations in structure and mechanical strength, especially in iron of 1.2 to 1.8 per cent. silicon content, are even more pronounced, fractures from mottled to grey occurring between narrow ranges of silicon variation. Sometimes 1.5 per cent. silicon iron is unmachinable, and at others is extremely soft. The author has found that this critical range corresponds with the passage through the maximum pearlite condition, the range being commercially that between mottled and No. 4 hard pig-irons, these irons becoming white or mottled when remelted. The abruptness of the pearlitic change is seen in Fig. I (*a*). The pearlite percentage in a series of Scotch pig-irons is seen to reach its maximum at about 1.25 per cent. silicon. Here the pig-iron fracture would be a close grey, but a thick fin or flash on the pig would be mottled or white in fracture. Such a pearlitic pig when remelted and cast into a 1.2-in. dia. bar would be mottled or soft-white in fracture when poured into a cold mould.

Fig. I (*a*) shows a method of graphing the structural composition of a series of pig-irons from a certain blast-furnace and was first used by the author in his A.F.A. Paper of 1925. It is perhaps the first attempt to produce a descriptive graph characteristic of the production of a blast-furnace working on a certain burden. From such a furnace graph the foundry metallurgist is enabled to choose the iron most suitable for his cupola mixture.

It shows clearly the critical character of the blast-furnace operation when running on 1.0 to 2.0 per cent. silicon irons, and should make foundrymen sympathetic towards the blast-furnacemen who are not infrequently asked to work to fracture *and* analysis when supplying pig-irons within this critical range. The request is at once seen to be unreasonable, and is the cause of innumerable quarrels.

The variations in the structure and mechanical properties of foundry pig-iron are reflected in the remelted metal, and it is obvious that the foundryman must take account of this fact when making up any cupola mixtures for the production of castings which must comply with a specification containing mechanical strength clauses.

In considering the mechanical strength of cast iron the metallurgical engineer is faced with the fact that considerable variation in tensile, transverse, torsional, compressive and impact tests must be looked for in a group of test bars cast simultaneously from the same ladle of metal in similarly prepared moulds cooled at equal rates. This is a disturbing fact, the reasons for the lack of uniformity having occupied the minds of foundrymen, engineers and metallurgists for many years.

The Institute of British Foundrymen has rendered a signal service to the engineering world by its attention to the matter of standard mechanical tests for cast iron, and in the many hundreds of bars of various sizes tested—of varying chemical composition—the values recorded for the tensile and transverse breaking loads in any one series of bars of similar size and approximately similar composition vary considerably from the mean of the series. The same kind of variation has been found in the many series of tests carried out by the British Cast Iron Research Association under conditions which have enabled the important details of the cupola mixtures, melting practice, pouring temperatures and cooling rates to be correlated with the analysis and micro-structure of the tested bars.

Work of a parallel nature has been done in the U.S.A., Germany, France, Belgium, Japan and elsewhere, the results of the tests on similar bars giving the characteristic variations. These indicate that the same causes for such irregularities are at work whatever casting material has been used—within the range of chemical composition common to the cast iron series. In this Paper the writer does not intend to convey the idea that the range of strength variations makes it impossible to arrive at a practical working mean in any particular narrow range of cast iron compositions, but, in view of the developments which are taking place in cupola melting practice, and in the

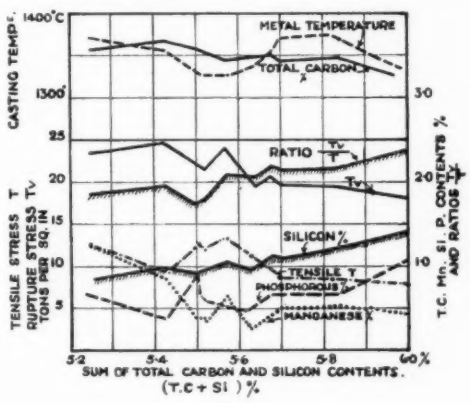


FIG. 1.

methods of casting and cooling the pieces, he would seek to call attention to some of the possible causes of these variations. Before doing this, a few typical examples of strength variations may be placed on record, drawn from reliable sources.

Example No. 1 is drawn from a series of 1.2-in. dia. dry-sand cast bars having the following range of chemical analysis:—T.C., 3.3 to 3.6; Si, 2.0 to 2.5; Mn, 0.3 to 0.65; P, 0.5 to 0.7; and S, 0.11 to 0.145 per cent.; the average analyses of the series being: T.C., 3.47; Si, 2.22; Mn, 0.52; P, 0.62; and S, 0.13 per cent.

Actually, the divergences from the mean are as under:—

	Per cent.		Per cent.		
T.C.	0.13 above, (3.75)	and	0.17 below (4.9)	mean	(actual values)
C.C.	0.12 (31.0)	,,	0.28 (72.0)	,,	,,
Gr	0.31 (10.0)	,,	0.14 (4.5)	,,	,,
Si	0.28 (12.6)	,,	0.12 (5.4)	,,	,,
Mn	0.12 (23.0)	,,	0.09 (17.3)	,,	,,
S	0.015 (11.5)	,,	0.02 (17.3)	,,	,,
P	0.05 (8.1)	,,	0.10 (16.2)	,,	,,

Total Carbon plus Silicon Contents.—These values were:—Maximum, 5.83; minimum, 5.57; and mean, 5.69 per cent.

* A Paper presented to the Sheffield Convention of the Institute of British Foundrymen.

Tensile Tests.—Maximum, 11.1; minimum, 8.3; and mean, 9.1 tons per sq. in.

Transverse Tests.—Maximum rupture stress (modulus of rupture), 23.8; minimum, 19.7; and mean, 20.9 tons per sq. in.

$$Ratio\left[\frac{\text{Rupture stress, tons per sq. in.}}{\text{Ultimate Tensile stress, tons per sq. in.}}\right] = \frac{Tv}{T}$$ Maximum 2.39, minimum 2.14, and mean 2.29.

The divergences in the contents of the various elements are expressed in percentages of the mean analysis values and are not abnormal. The differences in the mechanical strength of the irons are, however, seen to be considerable and are difficult to account for in terms of the analysis. When the tensile and transverse rupture stresses were plotted as ordinates over a base indicating the *total carbon plus silicon* contents, and the various elements also similarly plotted, it was seen that the ratio of the transverse rupture stress to ultimate tensile stress curve followed the silicon line closely in the above series (see Fig. 1), but in others the characteristics of the two curves were not so closely alike. The dominant influence of the two elements carbon and silicon is generally seen by thus plotting the results, and when the metal temperatures—as taken from the stream leaving the cupola spout—are also plotted, it is often possible to see the effect of varying metal temperatures.

In the series in question the spout temperatures were low when irons of between 2.0 and 2.2 per cent. were being tapped. The silicon, manganese, sulphur, phosphorus, and carbon curves show a series of kinks, all but the carbon showing what appears to be a fall in the contents due to greater oxidation at the lower metal temperature. The kinks are reflected also in the rupture stress/tensile stress curve. (See Fig. 1.) This ratio is of some—perhaps considerable—importance in connection with strength investigations concerning cast iron. The writer has elsewhere shown the connection of the ratio with the compressional and tensile strengths of cast iron, and has attempted to determine therefrom the relative values of these strengths; also the position of the neutral axis or plane in the transverse test bar when under load. The higher values of the ratio represent lower tensile strength, the curves showing these higher values as the silicon—and silicon plus carbon—contents are increased. It does not necessarily follow that the deflections of the transversely tested bars will increase in the inverse sense to that of the rupture modulus/ultimate tensile ratios; because of the lower tensile strength signified, for it is well known that a softer iron will sometimes give a better deflection than a harder one. The writer has found the Brinell figures to give fairly concordant results when comparing these with the carbon-plus-silicon values, and, as these are generally comparable with the rupture modulus/tensile ratios further research should make the Brinell test more useful than it has been in cast-iron investigations.

Example No. 2 is from a similar series of dry sand cast bars having the following range of chemical analysis:—T.C., 3.3 to 3.7; Si, 1.6 to 1.9; Mn, 0.40 to 0.96; S, 0.09 to 0.14; and P, 0.42 to 0.50 per cent.; the mean analysis being:—T.C., 3.45; Si, 1.77; Mn, 0.71; S, 0.11; and P, 0.46 per cent.

The divergences from the mean are as shown below:—

	Per cent.		Per cent.		
T.C. ..	0.24 (7.0)	above, and	0.16 (4.6)	below mean (actual values)	
Si ..	0.13 (7.2)	,,	0.17 (9.6)	,,	,,
Mn ..	0.19 (2.6)	,,	0.31 (4.2)	,,	,,
S ..	0.03 (2.7)	,,	0.03 (2.7)	,,	,,
P ..	0.04 (8.7)	,,	0.04 (8.7)	,,	,,

The figures in brackets give the variation in terms of the mean contents of the various elements, as in the case of Examples 1 and 3.

The variations in the combined and graphitic carbon contents were:—

	Per cent.		Per cent.
Gr	0.15 above, and (5.1)		0.25 below mean. (8.5)
C.C.	0.19 (36.0)	,,	0.27 (51.0) ,,

Total Carbon plus Silicon contents were:—Maximum, 5.44; minimum, 4.95; and mean, 5.23 per cent.

Tensile Results.—Maximum, 14.9; minimum, 10.6; and mean, 12.8 tons per sq. in.

Transverse Tests.—Rupture stress (modulus of rupture): Maximum, 27.5; minimum, 20.9; and mean 24.9 tons per sq. in.

The Ratio—Transverse Rupture Stress: Tensile Stress (ultimate) was found to be: Maximum, 2.25; minimum, 1.68; and mean, 1.81.

In a third series, Example No. 3 represents similarly cast bars to those in the two former series. The chemical analyses were:—T.C., 3.4 to 3.6; Si, 1.0 to 1.7; Mn, 0.5 to 1.0; S, 0.09 to 0.13; and P, 0.33 to 0.53 per cent.; the mean analysis being:—T.C., 3.55; Si, 1.43; Mn, 0.75; S, 0.11; and P, 0.41 per cent.

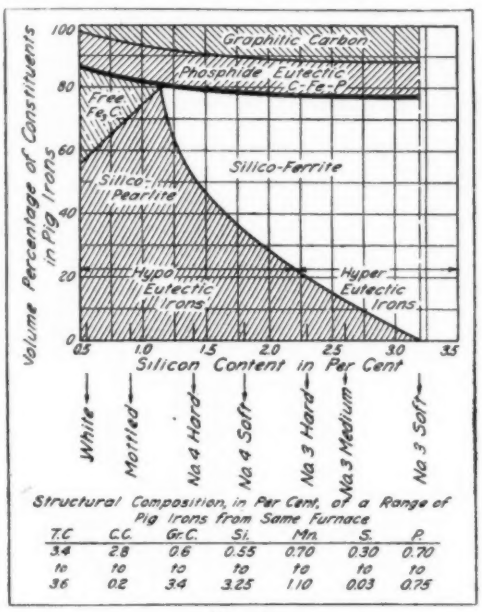


FIG. 1A.

The divergences from the mean were as follows:—

	Per cent.		Per cent.	
T.C.	0.04 (1.1)	above, and	0.06 (1.7)	below mean.
C.C.	0.09 (14.8)	,,	0.13 (21.3)	,,
Gr	0.14 (4.7)	,,	0.11 (3.7)	,,
Si	0.28 (19.0)	,,	0.37 (26)	,,
Mn	0.23 (30.6)	,,	0.22 (29.7)	,,
S	0.02 (18)	,,	0.02 (18)	,,
P	0.12 (29.3)	,,	0.09 (22.0)	,,

Total Carbon plus Silicon contents were:—Maximum, 5.28; minimum, 4.55; and mean, 4.99 per cent.

Tensile Tests.—Maximum, 15.1; minimum, 11.6; and mean, 13.0 tons per sq. in.

Transverse Tests (Modulus of Rupture).—Maximum, 25.9; minimum, 22.3; and mean, 24.4 tons per sq. in.

Ratio—Transverse Rupture Stress: Ultimate Tensile Stress: Maximum, 2.07; minimum, 1.72; and mean, 1.95.

Other series of tests, including the valuable results recorded by J. T. MacKenzie, in his A.F.A. Paper of 1926, have furnished closely comparable figures in which the interesting relationship between the Brinell hardness values and the carbon-plus-silicon contents is clearly brought out. These are graphed in Figs. 2 and 3. Two

sets of curves are shown, illustrating a series of irons of low manganese (below 0.5 per cent.), low phosphorus (under 0.5 per cent.), with variable carbon and silicon contents, Fig. 2, and higher manganese (0.5 to 1.0 per cent.), together with other two sets of curves, illustrative of higher phosphorus content (0.5 to 1.0 per cent.), Fig. 3.

Combined Functions of Total Carbon and Silicon.

In recording the results of the three examples of ordinary cast irons, the first of which is graphed in Fig. 1, it will be noted that the various curves showing the analyses, mechanical strengths and casting temperatures are plotted over a base representing the sum of the total carbon and silicon contents in each of the irons tested. If the total carbon content in each of the irons had been constant the silicon curve would have been a straight line in the case where the sum of the total carbon and silicon contents was constant or where the silicon contents progressively increased or decreased by a like amount from cast to cast throughout the series. The usual divergences of the carbon and silicon contents result in a broken line or curve, and this variably contoured line has been found by the author to give a most useful index to the effect of variations in analysis when plotted above the total carbon-plus-silicon base. Ledebur was probably the first to point out that desirable properties in cast iron could be expressed in terms of the total carbon and silicon contents, his results being shown in a formula which can be simply stated in the following form:—

Silicon content = 6.6 − 1.5 × total carbon content (max.) to 5.7 − 1.5 × total carbon content (min.).

The total carbon content is here made the basis for determining the silicon content, and, though the expression has been simplified in more recent days, Ledebur's fundamental conception that the sum of the total carbon and silicon contents in a cast iron are of first importance is now generally accepted, modified to suit the thickness of the casting, conditions of service required, and the mould temperature (Lanz hot-mould iron).

TABLE I.—*Ledebur's Table of Silicon with varying Total Carbon contents in Cast Iron*:—

T.C.	Si.		T.C.+Si.		$\frac{Si.}{T.C.+Si}$	
	Max.	Min.	Max.	Min.	Max.	Min.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
3.8	0.9	0.0	4.7	3.8	0.192	—
3.6	1.2	0.3	4.8	3.9	0.250	0.083
3.4	1.5	0.6	4.9	4.0	0.306	0.150
3.2	1.8	0.9	5.0	4.1	0.360	0.248
3.0	2.1	1.2	5.1	4.2	0.412	0.286
2.8	2.4	1.5	5.2	4.3	0.462	0.349
2.6	2.7	1.8	5.3	4.4	0.510	0.410

The preceding table is of interest as showing the Ledebur determinations of silicon per cent. in cast irons of total carbon content varying between 3.8 and 2.6 per cent. (3.8 per cent. T.C. being the maximum content the formula allows).

A glance at the table will show that the modern expression used regularly on the Continent, per cent. T.C. per cent. + Si per cent. = 4.0 to 5.2 has been directly deduced from Ledebur's original formula.

Ledebur (Das Roheisen: p. 57) expresses the T.C. and Si relationship thus:— T.C. + $\frac{Si}{1.5}$ = 4.2 to 4.4 and, for low Si irons the constants 4.2 and 4.4 may fall to 3.8.

This worker realised the function of the eutectic containing 4.3 per cent. carbon in cast iron structural strength connections, and it will be seen that the original formula expresses the view that $\frac{2}{3}$rds of the silicon content corresponds with the difference between the total carbon con-

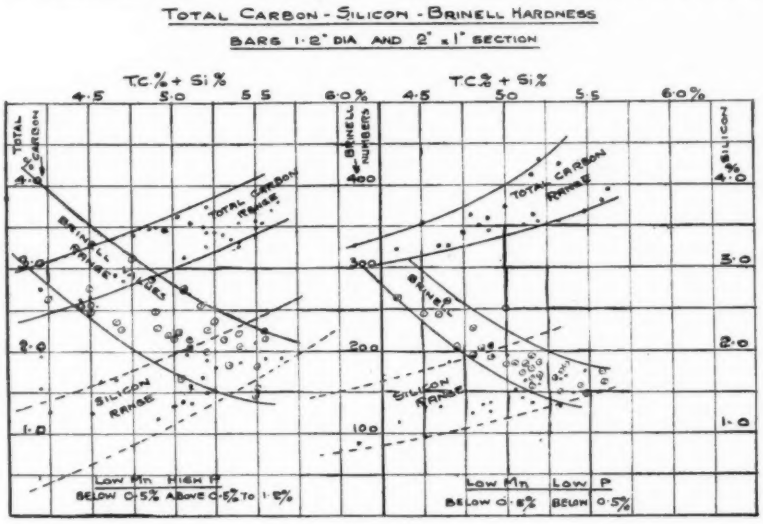


FIG. 2.

tent and 4.3 (which is the carbon percentage of the iron-carbon eutectic), in the compositions recommended for general service. Thus a 1.5 per cent. Si iron should have a T.C. per cent. of 3.3 when the eutectic constant 4.3 is used. The values given in Table I. when graphed above a T.C. + Si base, are shown in Fig. 2a. The T.C. and Si percentages for the maximum and minimum

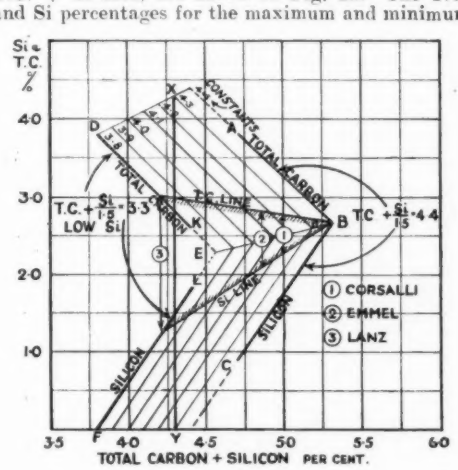


FIG. 2A.

values of the constants (4.4 and 3.8) are indicated by lines DK-LF and AB-BC respectively. The lines DK-LF, when extended, meet in point E and the line EB is the locus of the junctions of all other T.C. and Si lines corresponding to constants between 4.4 and 3.8. These junction points, such as E, O and B, illustrate the cast irons having similar T.C. and Si contents. The vertical YX represents the 4.3 per cent. T.C.

eutectic (Si per cent. = O) corresponding to the expression T.C. per cent. + Si per cent. = 4.3, where the maximum Si and minimum T.C. have like values; when T.C. + Si = 5.15 per cent. (point O). The triangle XYO graphically verifies the eutectic basis of the Ledebur formula. The diagram has a peculiar interest in showing the compositions (with respect to T.C. and Si contents) of modern cast irons of maximum strength. The writer has found that by drawing the lines FB, GB, the T.C. and Si contents of strong irons may be taken to vary between 3.0 and 2.6 per cent. T.C. and 1.2 and 2.6 per cent. Si. The triangle FBG gives the limiting T.C. contents line FB—and the limiting Si contents line GB.

The compositions of the strong Perlit, Emmel and Corsalli cast irons are indicated. Recent research has shown that Ledebur's work was of great importance, and it should be noted that, after Professor Turner's researches had proved the importance of silicon in cast iron, Ledebur indicated the fundamentals governing the combined effect of total carbon and silicon, or, at any rate, pointed out the direction in which future research should proceed in finding the conjoint influence of the two all-important elements.

Relationship between the T.C. + Si Contents and Mechanical Strength.

In Fig. 1 the actual results of a series of cast irons made for the experimental purpose of testing out the 1.2-in. dia. bar by the German Ironfounding Employers' Federation, Dusseldorf, have furnished the writer with the means for determining the influence of total carbon and silicon (primarily) on the physical properties of ordinary irons. Similarly, Mr. J. T. MacKenzie's experiments have enabled the Brinell hardness factor to be related to the iron composition. In both sets of tests the important function of the combined silicon and carbon contents in regulating the structural strength and hardness is confirmed, much additional works data having been examined before the author felt certain of his ground. Both the German and American results are representative of somewhat weaker irons than would result from British mixtures yielding similar analyses, but the many British tests examined confirm the accuracy of the fundamental trend of the combined silicon and carbon action as illustrated in Figs. 1 and 2.

(To be continued.)

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Influence of Iron Castings on Progressive Engineering.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In your issue of June 23, the writer "Progrès," after describing briefly the Lanz-Perlit and the Emmel processes, asks for some strong reasons why these processes have not been adopted by all the leading foundries of this country. I would like to indicate briefly some of these reasons, which are partly technical and partly commercial. Taking the Emmel process first: The original published data all referred to high silicon iron, between 1.9 and 3.2 per cent. silicon. (See *F.T.J.*, September 24, 1925.)

I think your correspondent is in error in classing the Emmel with the Perlit process for the production of low-silicon castings with a minimum heat growth (see foot of page 524). Emmel iron may be resistant to growth, but I have seen no information on this subject.

Turning now to the Perlit process, I agree that the results from Perlit iron are a distinct advance on ordinary practice, but I am convinced that a large amount of its virtues are due simply to the use of a low silicon, moderately low phosphorus iron. I have not yet seen comparisons of Perlit castings with cold-mould castings low in phosphorus and as low in silicon as compatible with machining.

Mr. Donaldson compared a Perlit iron containing 0.65 per cent. silicon and 0.17 per cent. phosphorus with a cylinder iron containing 1.48 per cent. silicon and 0.70 per cent. phosphorus. Naturally the comparison greatly favours Perlit, but cold-mould castings can be and are being made of much lower silicon than 1.5 per cent.

In the works with which I am associated small Diesel engine-castings with a section averaging say 1½ in. are cast in metal with silicon not over 1.1 per cent.; phosphorus 0.2 per cent., and total carbon 3.2 per cent. I have an analysis taken in 1923 from a large Diesel liner made by one of the largest and most successful continental makers of Diesel engines (who are not Perlit licensees). This shows: silicon 0.62; phosphorus 0.17, and total carbon 3.12 per cent. What advantages can the Perlit process offer over castings of this nature? So much for technical considerations.

I think, however, that most foundries who have investigated the claims of the "Perlit" process have turned it down for commercial reasons. The price asked for a licence was very high. It was a figure which could not, in my opinion, be justified by the research work done, and was, I believe, much more than was asked by Lanz before the formation of the English company. I understand that the cost of a licence has been reduced, so in this instance it pays to wait.

It would be very interesting to know how many Continental foundries are working under the Perlit licence, and how much they paid for it.

The progress of Perlit iron in this country has been hindered by exaggerated statements of its value, or of the inadequacy of castings made by ordinary methods. After one of the lectures which I heard by a prominent exponent of Perlit, I wondered how anyone ever dared to use such a totally unreliable material as cast iron. I was greatly relieved to find afterwards that locomotives and motor cars were still running and that the household mangle still managed to hold together.

After all, Perlit is still cast iron with perhaps 18 or 20 tons tensile strength, but with *no* elongation. The effect on design of the increased strength and resistance to impact can be easily overestimated. Many other factors, such as rigidity, thickness of flanges to take studs, allowance for reboring cylinders, etc., have to be taken into account.

In conclusion, might I suggest that foundrymen, even the more progressive, are just a little bewildered at the multifarious claims made for the developments of the last few years, which include the Perlit, Emmel, Corsalli, Meehanite processes, the use of nickel and chromium additions, improved melting units such as the Wüst furnace, the Schürmann and Poumay cupola, etc. Some of these were announced with the blare of trumpets, but now one hears little about some of them. Time will show their real value, and foundrymen have good reasons for waiting a little.

Meantime "Progrès" may be assured that in many directions real progress is being made, although it may not show itself in glowing press articles or patent applications.—Yours, etc.,

GUSSEISEN.

July 12, 1927.

Contracts Open.

London, S.E.1, July 26-August 5.—(1) 450-kw. steam turbine; (2) 375 tons zinc tiles or slabs; and (3) 231 sets of body fittings, etc., for rolling stock, for the Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. (Fee 5s. per set, non-returnable.) Tenders due August 5 for (1), July 26 for (2), and August 5 for (3).

Prestatyn, July 23.—(1) 7,000 yds. of 9-in. dia., 4,000 yds. of 6-in. dia., 3,000 yds. of 4-in. dia. cast-iron or steel pipes, together with the specials, valves, hydrants, etc.; and (3) pressure filters, for the Urban District Council. Mr. S. Trevor Roberts, water engineer, Council Offices, Prestatyn, Flints. (Fee £2 2s., returnable.)

Rolled Steel for Electrical Machine Construction.—The General Electric Company of America is extending the use of welded steel plate and shapes going into large motors and generators, especially in large units in which rolled steel is replacing castings. Stator and magnet frames, rotor and armature spiders, baseplates and other details are being made of welded steel plate.

Stresses in Non-Ferrous Castings.*

By Prof. Cecil H. Desch, D.Sc., F.R.S.

The existence of internal stress in castings is a frequent cause of failure, giving rise to defects which are familiar to every foundryman. All metals are liable to internal stresses when cast into shapes which allow of the cooling of different parts at unequal rates, but the trouble is apt to present itself in a more acute form in the non-ferrous foundry than in the iron foundry, owing to the conditions of solidification. The greater the change of volume during solidification, and the greater the solid contraction during cooling, the more severe the stresses which will be developed. Cast iron contracts on freezing, but very shortly afterwards an expansion occurs, owing to the liberation of graphite, and this expansion partly neutralises the effect of the contraction, so that stress is to that extent relieved. Steel, on the other hand, does not undergo an expansion, and as its casting temperature is very high, there is a long range of temperature over which contraction is occurring in the solid state, and the liability to internal stress is therefore great. Cooling stresses of this kind will obviously be in greater proportion, as the reduction of volume on freezing and the solid contraction are greater, but other factors are also involved. A very soft metal, such as lead, will yield to stress so that the casting will deform more or less, but will not crack. On the other hand, a hard bronze or nickel alloy, with a high elastic limit, even at temperatures above that of the atmosphere, will be unable to yield, and is likely to develop cracks. Table I gives the contraction on freezing and the mean coefficient of linear contraction in the solid state of the principal pure metals, but few data as to their yield when hot are available.

TABLE I.

Metal.	Coefficient of linear expansion. $\beta \times 10^6$.	Change of volume on melting. Per cent.
Aluminium ..	27.4	6.4
Antimony ..	10	1.4
Bismuth ..	13	3.2
Cadmium ..	31	4.7
Copper ..	16.5	4.0
Gold	14.5	5.2
Lead	29	3.4
Magnesium ..	29	—
Nickel	16	—
Silver	24	5.0
Tin	22	2.8
Zinc	26	6.5

Simple shrinkage is in itself able to account for quite considerable stresses, but in some metals and alloys the effect is accentuated by the crystalline nature of the material. Metals such as copper, silver, iron, lead and aluminium crystallise in the cubic system, and their contraction is the same in all directions, but others, such as zinc, bismuth, antimony and cadmium, crystallise in less simple forms, and contract more in one direction than in another. For instance, the coefficient of expansion (or contraction) of bismuth is 16.2×10^{-6} parallel to the axis and only 12.0×10^{-6} perpendicular to the axis, and although accurate determinations of this kind have not been made for other metals, it is certain that all metals and alloys which do not crystallise in the cubic system must show similar differences. Such metals, for example zinc, usually form crystals which are much longer in one direction than in any other, and the high contraction in the direction of greatest length sets up stresses which may be considerable. Moreover, such crystals grow most rapidly along the axis, and exert a measurable thrust in so doing. A consequence of this is that when a casting, such as a long bar, begins to freeze, the outer shell, which first solidifies, consists of long crystals, thrusting against one another and causing an apparent expansion, leaving small cavities in the interior. For this reason, many brasses and other alloys have been recorded as expanding during freezing, whilst a determination of the density proves that no real expansion has taken place, but that the cast bar is minutely porous. An outer shell which has solidified in this way is in a state of stress, which is greater the greater the difference in the coefficients of expansion of the crystals in two directions at right-angles to one another.

It follows that a mere knowledge of the coefficients of expansion of metals and alloys counts for little in deciding how much shrinkage will be found in a casting, and empirical measurements of actual castings of simple form are of greater value. The shrinkage observed in this way is the net result of a number of separate changes, which may partly neutralise one another. As an example, the values of the shrinkage of light alloys of aluminium may be considered. Various writers have given figures, which differ remarkably little from one another, as the composition is varied within wide limits, although every foundryman knows that the differences in actual shrinkage are very large, and that this accounts in large measure for the popularity of the alloys with silicon, which show a smaller shrinkage than most alloys of the kind.

When an alloy consists of two constituents of very different physical properties, stresses may easily be set up. The gun-metal and similar alloys mostly contain the eutectoid of copper and tin, a hard, brittle material. The difference in contraction between this and the adjoining solid solution is so great that small cracks often start from the patches of eutectoid. Rapid cooling will diminish the size of any such inclusions, and thus lessen the concentration of stress. Although rapid cooling might be expected to cause thermal stresses, this is often more than compensated for by the smaller size of the crystals and by their less regular arrangement, causing a more even distribution of the small residual stresses. It is for this reason that chill castings may be more free from stress than sand castings, although at a first glance the contrary might be expected to be the case. When the chill is very severe, as in pressure die-casting, there may be great shrinkage stresses, and this has been observed with aluminium alloys. Pistons, when die-cast under pressure, have been known to separate into two concentric shells, completely distinct from one another, owing to sharp contraction stresses between the two rapidly-chilled surfaces. Ordinarily, when the feeding of the die-casting is properly provided for, the metal obtained is comparatively free from internal stress, unless the alloy is of such a kind that a transformation may continue in the solid state after solidification. Such a condition appears to be responsible for the warping of some zinc base die-castings in the course of time. The alloys of aluminium with zinc contain an unstable phase, and the gradual change to the stable condition sets up stress. As an example, die-cast tensile test pieces of an alloy of 93 per cent. zinc, 4 per cent. aluminium, and 3 per cent. copper, showed a distinct falling off of tensile strength after one year, but the resistance to shock was very greatly reduced, falling in the same time from 76 to 8 ft.-lb. sq. in., although chemical action was prevented. This effect must be attributed to internal stress.

Many alloys pass through a brittle range during the process of cooling, and within certain limits of temperature they are easily fractured. All alloys of copper and zinc have this property. For cast brasses of the alpha-beta type this range lies in the neighbourhood of 300 to 500 deg C., and a similar range is found in the tin bronzes. Advantage is taken of this fact in knocking off the runners of castings, but it is obviously dangerous to shake or handle castings while within this range of temperature.

Any local heating subsequently to casting is liable to set up stresses. Burning-on at defective places is a prolific source of trouble. It may happen that the burnt-on portion may appear to be quite sound, and that cracking will occur at a

* A Paper read before the Sheffield Convention of the Institute of British Foundrymen.

later stage. Monel-metal castings which have been treated in this way sometimes crack violently some ten minutes after making the weld. Such trouble can only be avoided by annealing, taking care that the metal cools from the welding temperature slowly enough to allow of the gradual relief of stress. Large castings have sometimes split suddenly without known cause, and the presence of dissolved gases has been suspected as being responsible. Much work is now in progress on the removal of gas from casting metal, and it remains to be seen whether the measures which are recommended will lead to the production of castings which are less liable to crack as the result of internal tension.

A remarkable case of cracking of castings through internal stress is that of the valve castings used in the construction of the Catskill Aqueduct for a supply of water to New York, an account of which was published in 1915. These castings were of the alloy usually called manganese bronze, and were very large, sometimes up to 10 tons in weight. Although they had been subjected to hydraulic test pressures of 200 or 300 lb. per sq. in. for half an hour or more, they developed leaks some months later under very small pressures, and these leaks became larger in course of time. An analysis of one of the castings gave:—Copper, 58.5; zinc, 39.1; tin, 1.0; iron, 1.4 per cent.; lead, trace, and manganese, none. The structure was that of an approximately 60: 40 brass, composed of beta crystals containing numerous isolated alpha crystals. Many of the valves and other objects had been repaired by "burning-in," cracks and other defects being filled by melting in some of the same material. Sound welds were obtained in this way, and the castings had every appearance of

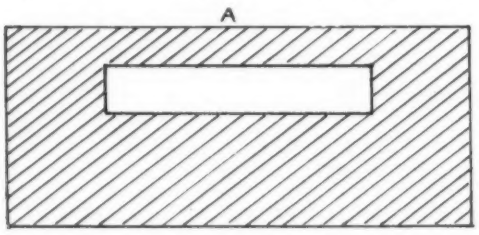


FIG. 1.

being in good condition. It was only after an interval of time that failure occurred. The matter was investigated by the U.S. Bureau of Standards in 1916, and experiments were made by casting frames of the shape shown in Fig. 1, cutting through at the point A, and burning in a supply of the same metal, making a weld. By sawing through this arm of the frame, after having removed the pouring gate, it was possible to measure the stress in the casting by measuring the change in distance between two gauge points previously marked. Tensile stresses ranging from 2.8 to 4.3 tons per sq. in. were found to exist. Calculations showed that a stress four times as great might have been expected theoretically, so that in all probability there had been some plastic yielding of the alloy, the elastic limit being exceeded. This would leave the other parts of the casting near to the repair in a state of severe internal stress, similar to that which is found in a severely cold-worked metal. The subsequent cracking would then be of exactly the same kind as the "season-cracking" of cold drawn tubes and rods. It would not occur immediately, but after an interval, as in season-cracking. The failure was not in any way due to the weld metal itself, which gave normal tests and structure, but to internal stress, which could not be removed by subsequent annealing, owing to the large size of the castings.

A more obscure condition of stress, in which the writer has taken particular interest, is that which manifests itself between the individual crystal grains of a cast metal. It is well known to all who have been concerned with the casting of marine propellers in manganese bronze or similar alloys that occasionally a brittle casting is obtained, which may fracture on a blow, invariably showing a coarse intercrystalline fracture. A fragment of a broken propeller of this kind is shown in Fig. 2. In this case fracture occurred when a blade of the propeller happened to strike a floating plank. The crystal grains of such castings are occasionally of enormous size, the shape of one, which was of the size of a turkey's egg, being shown in Fig. 3. In the writer's experience, castings which have behaved in this way have always consisted either of the beta constituent only, or of beta with a relatively small proportion of alpha, and they have contained a high proportion of alu-

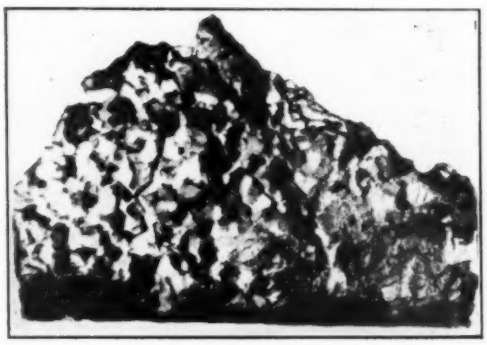


FIG. 2.

minium. The late Prof. Huntington noticed that very coarse crystalline alloys of this kind would disintegrate if placed in mercury, and this test has proved useful. The fragment of propeller in question, if immersed in mercury, will break up in the course of thirty seconds into a loose mass like sand, each particle being a single crystal grain. Other specimens disintegrate more slowly, and the process may take minutes or hours. Others, again, although with grains as coarse as the specimens in question, are not loosened by the action of mercury, but are evenly amalgamated without penetration along the grain boundaries. The effect strongly recalls the use of mercury or of mercuric salts as a test for season-cracking. Cold-worked brasses are sometimes in a condition in which spontaneous cracking may occur, perhaps months after manufacture, on exposure to corrosive fumes or by a change of temperature. The mercury test produces sudden cracking, which is evidence of internal stress. Reasoning from analogy, it may be supposed that the castings which respond to the action of mercury in this way are also in a condition of stress, and this conclusion is almost certainly justified. A comparison may be made with the action of tin or solder on brasses at high temperatures, to

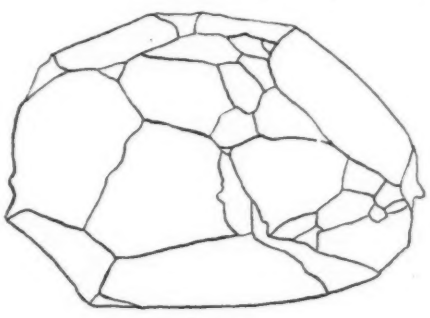


FIG. 3.

which attention was first directed by Dickenson, who described a beta brass (so-called manganese bronze) of the following composition:—

Copper, 55.75; zinc, 36.77; manganese, 3.87; and aluminium, 2.56 per cent., which cracked owing to the penetration of molten solder between the grains. It was shown that the solder could only penetrate while the brass was under tensile stress, and the alloy could be brought into contact with liquid solder when the specimen was under compression or on the compression side of a bent bar without producing any effect. Failure under tension was obtained in a number of

brasses, and in most instances the penetration could be seen to follow the boundaries of the beta grains. The more regular the polyhedral structure of the brasses the more readily such failure occurred. A very similar kind of fracture is seen when gases penetrate into metals, as for example, when hydrogen is forced by electrolysis into copper or iron. The gases penetrate along the grain boundaries and may readily cause rupture. Brasses which on slow cooling give an alpha and beta structure fracture more readily in contact with mercury or with molten metals when quenched from a sufficiently high temperature to give them the structure of a homogeneous beta alloy. The writer has made a large number of experiments for the purpose of discovering the exact conditions under which disintegration could be brought about by mercury. A complete beta structure is the most favourable, and it appears that the presence of some metal other than zinc is usually necessary. In one series of experiments brasses were made to have a simple beta structure by varying the zinc and adding a sufficient quantity of aluminium, manganese or silicon. It was found that 2 per cent. of aluminium

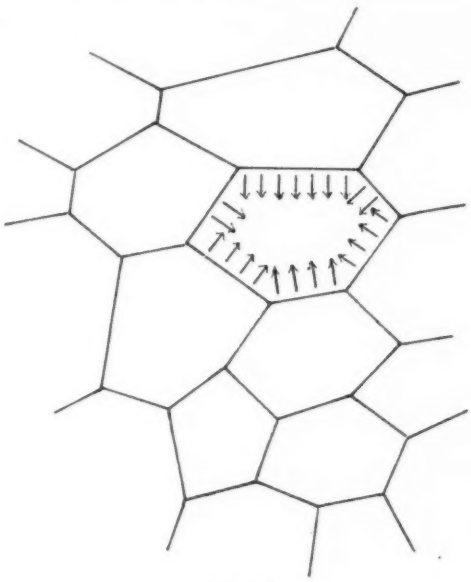


FIG. 4.

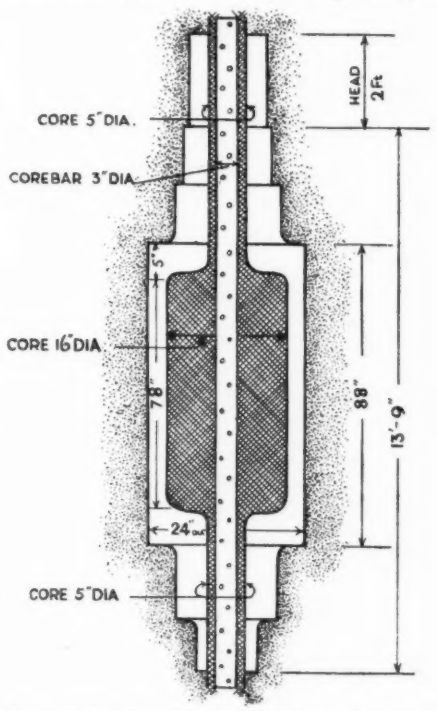
was necessary to produce disintegration, but this might be replaced by a rather larger quantity, perhaps 3 per cent. of silicon. On the other hand, manganese did not tend to develop this type of brittleness, and it is of interest to notice that in the Japanese navy much attention has been given to alloys containing as much as 4 per cent. manganese for the castings of propellers, and it is understood that these are not so liable to exhibit great brittleness. That the question is not merely one of chemical composition is shown by the behaviour of a casting which was examined recently. The analysis of this casting was:—Copper, 64.40; zinc, 26.55; iron, 1.55; manganese, 1.84; and aluminium, 5.30 per cent., with only minute quantities of other metals. The structure was that of a beta brass and the mechanical properties in the cold were excellent, although it was possible to produce a brittle intercrystalline fracture by moderate heating. Mercury did not cause disintegration unless the surface to which the mercury was applied was in tension. The aluminium in this alloy is remarkably high, and nevertheless direct disintegration by mercury without stress was not produced. When the surface of an alloy of this kind is amalgamated and a section is cut through and examined by means of the microscope (special precautions being necessary to avoid the smearing of the amalgam) it is seen that amalgamation has advanced along the grain boundaries, whilst the crystals as a whole are unchanged. The behaviour of castings having the simple polygonal grain structure of beta brass may be illustrated by Fig. 4. These polygonal masses contract in cooling, and there is, therefore, a tendency for each grain to pull away from its neighbours, the stress in one such grain being indicated by arrows. The more simple the form of the boundaries the more likely is rupture to occur, and this is in accordance with the fact that such brittle fractures are almost always accompanied by a simple polygonal structure. Whether it is considered that an amorphous material exists between the grains or not, it is certain that chemical action, including amalgamation by mercury, can proceed most readily along the boundaries, and when considerable stresses are present at those boundaries the material may break up. It seems very probable from analogy with season cracking that rupture by chemical means does not occur unless a state of stress exists in the region to which the reagent penetrates. Why there should be so much difference between different castings remains unexplained.

Foundry Query.

Hollow Rolls.

I am a foreman moulder and I have been a subscriber to your paper for many years.

My firm have to make some cast-iron chilled hollow rolls, 13 ft. long overall by 28 in. diameter body, as shown in the sketch. Up to now I have made a number of hollow rolls, but only up to 20 in. diameter, and with a little larger core, and



I have always loamed up the core on a steel pipe, and it has always been very satisfactory.

All these rolls have bodies 88 in. long by 24 in. diameter, and with such a lot of metal round the corebar, and the corebar being so small at each end, I am afraid the metal might eat into it. Could you kindly let me know how the cores for these rolls are usually made? Perhaps they are made of sand cores, and not with steel core bars.

You will understand I wish to make a success of these, and I trust one of your readers will be able to give some useful information.

FOREMAN.

THE SUMMER MEETINGS of the Institution of Naval Architects in Cambridge started on Tuesday, July 12, when the Vice-Chancellor of the University welcomed the members in the Senate House. On Thursday honorary degrees were conferred upon the president, His Grace the Duke of Northumberland, Sir Archibald Denny, Bart., and Sir Eustace T. d'Eyncourt.

THE STAVELEY COAL & IRON COMPANY, LIMITED, Chesterfield, have an order from the Southend Corporation for the supply of about 3,200 tons of cast-iron sewer pipes of 60 ins. diameter.

Census of Production in the Engineering Trades, 1924.

The Board of Trade has issued its Preliminary Report (No. 16) on the Third Census of Production conducted in connection with the Engineering Industry.

From the returns received it appears that the total selling value of machinery and other products and work done during the year 1924 included the following items:—

General Engineering.

	£
Blast-furnace and steelworks plant ...	951,000
Boilers and boiler-house plant (including economisers, feed-water heaters, and steam superheaters)	7,516,000
Conveyors, telphers and transporters...	1,085,000
Cranes, hoists and other lifting machinery	4,303,000
Machine tools (metal working)	3,366,000
Mechanical power-transmission plant...	1,213,000
Mining coal-cutters	595,000
Other mining machinery (including washing and screening plant, pit-gear, etc.)	1,812,000
Prime movers (not electrical) other than marine engines, locomotives and tractors	9,229,000
Pumps, not included elsewhere ...	1,898,000
Weighing machinery	1,846,000
Locomotives (rail)	4,265,000
Special steels	147,000
Iron and steel castings	4,493,000
Iron and steel forgings	1,524,000
Tools and implements	516,000
Other manufactures of iron and steel...	4,570,000
Iron and steel structural work done ...	9,823,000

Electrical Engineering.

Electrical machinery and parts... ...	15,432,000
Carbons, electric (including furnace electrodes)	565,000
Electric lamps and parts...	2,432,000
Telegraph and telephone apparatus ...	3,872,000
Electric wires and cables (insulated) ...	18,444,000
Accumulators (including parts)... ...	3,520,000
Electric lighting accessories and fittings (including switches)	1,561,000
Switchboards (other than telegraph and telephone)	1,659,000

Comparison with 1907.

In the year 1907 the gross value of goods made and work done in Great Britain by firms whose returns were made on schedules for the general engineering and the electrical engineering trades was £102,080,000, of which £88,191,000 represented output shown by general engineers and £13,889,000 by electrical engineers. The aggregate value returned for these two sections, taken together, for the year 1924 was £223,759,000, of which the total value shown by general engineers was £153,821,000, and that by electrical engineers £69,938,000. The two latter figures contain some unclassified output, which, on allocation to the correct schedule headings, may disturb to some extent their relationship to each other, but the amount of this output is, relatively, not considerable. In order to show the output of the two years on a common basis it is necessary to deduct from the gross figure shown for general engineering in 1924 (£153,821,000) the value of marine engines and machinery made by shipbuilding firms, these being included in 1907 in the general returns made by shipbuilders, and not in those relating to the engineering trade. The gross output of these marine engine works in 1924 was valued at £13,662,000, and the aggregate for the general engineering trade on the 1907 basis may thus be taken as £140,159,000.

Excluding the output of marine engine works operated by shipbuilding firms, the value of electrical engineering production in 1907 formed about 14 per cent. of all production returned by the general and the electrical engineering trades taken together. In 1924 over 33 per cent. of the aggregate value of production of these industries was returned by firms who were primarily electrical engineers.

The aggregate value of all machinery and parts and accessories (excluding locomotives and tractors) produced in 1924 by firms making returns on schedules for the general engineering trades was £100,374,000, while in 1907 the total value of goods of a similar kind made in the United Kingdom was approximately £55,000,000, this latter figure being inclusive of marine machinery made by shipbuilding firms. Measured on a value basis only, the 1924 figure relating to the production of the general engineering trade in Great Britain exceeds that for 1907 (which is inclusive of production in Ireland) by about 82 per cent. For the electrical engineering trade the value of the main classes of output and work done recorded in 1907 was £13,897,000, and in 1924 it was £64,487,000, an increase of about 364 per cent.

When allowance is made for the advance in prices, it is clear that the volume of production in the general engineering trades in 1924 showed little, if any, increase over that in 1907, and in certain special types of machinery, *e.g.*, textile machinery and steam engines, the 1924 figures indicate a heavy decline. On the other hand, a very considerable development occurred in electrical engineering production. The figures afford a rough indication of the extended use of electrical energy which has taken place since the earlier year.

Net Output.—The net output of the engineering industry in 1924 was £117,062,000, representing the amount by which the total value of the output (£223,759,000) exceeded the total cost of materials purchased and used (£101,748,000) and the value of work given out (£4,949,000). The net output per head of persons employed in 1924 was £199 and in 1907 £109.

Persons Employed.—The average number of persons employed in the engineering industry in 1924 was 587,822, of which 493,711 were recorded as operative staff and 94,111 as management, technical and clerical staff. The average number returned for the year 1907 was 454,973, of which 416,092 were returned as wage-earners and 38,881 as salaried persons. The relative increase in the number of management, clerical, etc., employees is in this case considerably greater than in the aggregate of the trades surveyed in preceding reports.

Power.—The total capacity of engines at the works to which this statement relates was 388,332 h.p., of which about 30 per cent. was in reserve or idle during the year. The total h.p. of engines at engineering factories in Great Britain during the year 1907 was returned as 327,926. The main types of engine power employed in the two years are shown in the following statement:—

Kind of engines.	Horse-power.	
	1924.	1907.
Steam engines, reciprocating ..	187,262	249,542
,, turbines	108,467	5,936
Internal-combustion engines ..	91,476	63,577
Other power	1,127	8,871
Total	388,332	327,926

In addition to the engine power recorded above for 1924, electric motors of an aggregate capacity of 732,575 h.p., driven by purchased electricity, were also returned. About 17 per cent. of these motors were shown as in reserve or idle during the year. No information is available for 1907 as to the h.p. of electric motors at factories. The particulars available for the year 1912 indicate that, in that year, the motors driven by purchased electricity did not reach a total of 200,000 h.p. The capacity of electric generators at factories in 1924 and 1907 is given below:—

Electric generators.	1924.	1907.
Driven by:—	Kw.	Kw.
Steam engines (reciprocating)..	59,576	73,415
Steam turbines	73,451	5,456
Other power	33,925	13,635
Total	166,952	92,506

About 35 per cent. of the capacity of the generators recorded in 1924 was in reserve or idle during the year. The total h.p. of motors driven by electricity generated at engineering works in 1924 was 280,628, and of this aggregate capacity 20 per cent. was in reserve or idle.

Trade Talk.

THE GOODYEAR TIRE & RUBBER COMPANY of America will manufacture tyres, tubes and rubber products in England. Mr. Chas. A. Stillman, vice-president of the American company, has been in England for several weeks in connection with the organisation of the Goodyear Tyre & Rubber Company (Great Britain, 1927), Limited, which company has just acquired factory buildings on a site of some 22 acres located at Wolverhampton. Enlargement of the buildings and the installation of machinery and equipment will begin immediately, and the plant should be in active operation by the end of this year or early 1928. Mr. Stillman states that the new plant will have a capacity of 2,000 tyres and 2,000 tubes per day, and furnish work for over 1,000 employees.

CROMPTON & COMPANY, LIMITED, have entered into a provisional contract for the acquisition of all the shares of F. and A. Parkinson, Limited, who, for some years, have carried on the manufacture of alternating current electrical motors in a factory laid out for quantity production at Guiseley in Yorkshire. Under the scheme of amalgamation, the details of which are summarised, the existing 7 per cent. non-cumulative participating preference shares become 8 per cent. cumulative non-participating preference shares, and the existing ordinary shares become 6 per cent. cumulative preferred ordinary shares. Crompton & Company, Limited, acquire the whole of the issued share capital of F. and A. Parkinson, Limited, in exchange for the issue of the following shares in Crompton & Company, Limited, credited as fully paid :—30,000 8 per cent. cumulative shares of £1 each, fully paid, and 50,000 deferred ordinary shares of £1 each, fully paid.

SIR HENRY FOWLER, K.B.E., LL.D., the president of the Institution of Mechanical Engineers, and Brigadier-General Magnus Mowat, the secretary of the Institution, were among the guests at the annual summer meeting of the Institution at Cardiff on July 14. The party, numbering 70, proceeded to the Cardiff Docks in the morning and there inspected the Great Western Railway Company's new electric hydraulic station, and also some of the latest coal-shipping appliances. Following the inspection, Mr. C. J. T. Billingham, the chairman of the South Wales Branch of the Institution of Mechanical Engineers, presided at a luncheon, and in proposing the toast of "The President and Secretary of the Institution of Mechanical Engineers and Guests," remarked that the object of the summer meeting had largely been fulfilled when they had inspected some of the most modern appliances at the docks, and which, without doubt, had greatly added to the facilities and benefits of the port generally. The additions which had been made to the appliances at the docks had enabled the port to deal more easily with the exacting conditions of trade and competition which existed to-day.

Company Meeting.

Darlington Forge, Limited.—SIR THOMAS PUTNAM, presiding at the annual meeting of this company, at Darlington, remarked that the accounts—which showed a loss of £19,832—covered a period during which the work of the company was greatly interfered with owing to the general strike and the coal dispute. Steel furnace, pattern, and cleaning shops were idle through lack of coal, and in that period they had to purchase any steel they could obtain to carry on contracts, which meant heavy prices. The difficulties had naturally made the results bad; but they should not be regarded as unsatisfactory, considering the conditions. The liquid assets of the firm had been largely depleted by losses during the past seven years, and as the quantity of work placed with the company increased, it had become necessary to provide money for wages and material. Hence the issue of prior lien debentures by arrangement with the debenture holders.

Company Reports.

Midland Iron Company, Limited.—Loss on trading, £1,710; depreciation, £3,458; total loss for year, £5,168.

John Baker & Company (Rotherham), Limited.—Dividend on preference shares for half-year ended June 30.

Bradley & Foster, Limited.—Net profit, £6,626; brought in, £165; income tax reserve, £1,000; depreciation, £5,000; carry forward, £791; directors have ascertained company's liability for income tax up to 1926, and £3,691 over-reserved on this and other accounts has been transferred to general reserve.

Personal.

MR. H. Y. CARSON, Mr. W. D. Goldsmith and Mr E. H. Ballard have been elected directors of the American Foundrymen's Association.

MAJOR S. J. THOMPSON, of Codsall, a director of the firm of John Thompson, Limited, Ettingshall Boiler Works, Wolverhampton, has been adopted as prospective Unionist candidate for the Bilston Division.

MAJOR J. W. ATHEY, managing director of the Fordath Engineering Company, Limited, West Bromwich, entered a nursing home at Edgbaston, on July 11, to undergo a severe operation for internal trouble. The operation was very successful, and he is now making satisfactory progress towards recovery.

Wills.

MITCHELL, C. Y., governing-director of Thomas Mitchell & Sons, Limited. Bolton	£29,382

A New Refractories Works.

Finding their manufacturing capacity quite unequal to the demand upon it, the General Refractories Company, Limited, of Sheffield, have purchased the control of the Worksop Brick Company, Limited, Worksop, Notts. (a few miles from Sheffield), and are proceeding to the erection there of a modern refractories works on an almost ideal site, adjoining L.N.E. and L.M.S. Railways, road and canal.

The new works will embody the most recent advances in fuel economy and labour-saving devices, and enable the company to manufacture a product as perfect as possible, at a cost as low as can be ensured by a plant laid out in the light of fourteen years' experience.

Mr. Frank Russell, F.G.S., the chairman of the company, states that it is intended to make full use of the information accumulated during recent visits to firebrick works and refractories plants on the Continent and in the United States, and the results of scientific research which have been published in the Press during the past few years.

Catalogue Received.

Steel Castings.—Whilst we are constantly favoured with the publicity matter of the foundry suppliers, the large engineers and iron and steel manufacturers, we seldom receive, without asking, the catalogues of the various foundries. Many firms include in their general catalogue a page or two in which they outline their foundry specialities, and give a weight range. Messrs. Edgar Allen & Company, Limited, of Imperial Steel Works, Sheffield, however, have achieved a noteworthy position in the foundry world as pioneers of an excellent foundry publicity service. Their booklet, "Edgar Allen Steel Foundry Book" (Catalogue C, 2nd Edition), is a brilliant example of how foundry products should be brought to the notice of the buyers. It quietly and quite rightly assumes that the supplier can teach the engineer something of the nature of castings, ultimately for the latter's benefit, and incidentally for the general good of the industry. Apart from this paternal attitude, service is constantly stressed throughout the 40 well-written and well-illustrated pages. Sheffield is credited with "blinding buyers with science," and the introduction of a little micrography and thermal analysis, whilst perhaps not providing patients for St. Dunstan's, does create an atmosphere that, after all, foundry work is something more than merely making holes in sand and filling them with metal.

The sections which are of the greatest value to the foundry industry are those bearing the captions "Proper Patterns Required by the Foundry" (page 30), and "Save Money when Designing Castings" (page 31), and they constitute phases which, if all the founders would only copy, would save the industry thousands of pounds per year. Bad patterns and poorly designed engine parts cause a continual leakage of money, which only real co-operative effort on the part of the industry will stem.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—As noted in previous reports, the state of the Cleveland iron trade becomes more unsatisfactory week by week, while the present outlook, if not obscure, is distinctly disappointing as concerns an early revival of activity in the industry. As indicating the seriousness of the position, two more furnaces were damped down during the past week, thus leaving only 40 in blast on the North-East Coast, of which 16 are producing Cleveland iron. This policy has been adopted by Tees-side ironmasters as an alternative to price-cutting, which in present circumstances, they claim, in view of the high cost of production, is practically impossible. Business is therefore still confined to purchases for prompt delivery. Nobody will discuss forward business, because no inducement is offered to do so. What is the use of buying three months ahead, they ask, when not the slightest reduction in price is offered for a long contract? Quotations consequently remain unaltered, as follow:—No. 1 Cleveland foundry iron, 72s. 6d. per ton; No. 3 Cleveland G.M.B., 70s.; No. 4 foundry, 69s.; No. 4 forge, 68s. 6d. per ton, f.o.t. or f.o.b.

Rather more activity has been marked in the hematite section, especially for shipment abroad, the home demand, however, remaining quiet, with quotations unchanged at 76s. 6d. for East Coast mixed numbers, with 6d. per ton extra for the No. 1 quality. On the North-West Coast prices are firm, with Bessemer mixed numbers quoted at £4 6s. per ton delivered at Glasgow, £4 10s. per ton delivered at Manchester, £4 12s. 6d. per ton delivered at Sheffield, and £4 14s. per ton delivered at Birmingham.

Metals.

Copper.—Conditions in the market for warrant copper of late have been generally quiet, the lack of animation being largely ascribed to the continued colourless and somewhat disappointing reports about the progress of the transatlantic trade. The market has been occasionally supported to some extent by dealers, but the volume of trading has been kept at below the normal. Nevertheless, the improvement which was noted earlier in the month has been sustained.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £53 17s. 6d. to £53 18s. 9d.; Friday, £54 6s. 3d. to £54 8s. 9d.; Monday, £54 11s. 3d to £54 12s. 6d.; Tuesday, £54 17s 6d. to £54 18s. 9d.; Wednesday, £55 10s. to £55 11s. 3d.

Three Months: Thursday, £54 8s. 9d. to £54 10s., Friday, £54 16s. 3d. to £54 18s. 9d.; Monday. £54 17s. 6d. to £54 18s. 9d.; Tuesday, £55 3s. 9d. to £55 5s.; Wednesday, £55 16s. 3d. to £55 17s. 6d.

Tin.—Though closing fractionally lower at the week-end, the position in the market for standard tin may claim a slightly steadier tendency, especially in regard to spot cash metal. The easier tendency in forward tin has been largely due to the somewhat freer selling done in the Eastern markets at the decline. This month's Straits shipments will probably be lighter. The Continental outlet seems quite good, but, on the other hand, home consumption is on the light side.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £286 7s. 6d. to £286 10s.; Friday £290 5s. to £290 10s.; Monday, £291 5s. to £291 10s; Tuesday, £285 15s. to £285 17s 6d.; Wednesday, £286 to £286 2s. 6d.

Three Months: Thursday, £280 2s. 6d. to £280 5s.; Friday, £282 2s. 6d. to £282 5s.; Monday, £282 to £282 5s.; Tuesday, £279 12s. 6d. to £279 15s.; Wednesday, £280 2s. 6d. to £280 7s. 6d.

Spelter.—Movements in the market for ordinary spelter have been irregular, but, on the whole, there is a slight inclination to weakness. On the other hand, there has been a little restraint in the way that July was offered, with the result that at one time a backwardation was established.

The following are the week's prices:—

Ordinary: Thursday, £27 17s. 6d.; Friday, £28 3s. 9d.; Monday, £28; Tuesday, £28 5s.; Wednesday, £28 11s. 3d.

Lead.—Dealings in the market for soft foreign pig have been on a moderately good scale, and this has had the effect of maintaining prices. The position is still unsettled, with not much hope of any permanent improvement being experienced for some time.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £22 17s. 6d.; Friday, £23 3s. 9d.; Monday, £23 7s. 6d.; Tuesday, £23 6s. 3d.; Wednesday, £23 13s. 9d.

BLACKING,
PLUMBAGO,
CORE GUM,
WHITE DUST,
COAL DUST.

ESTABLISHED 1863

JAS. DURRANS & SONS, LTD.
PHOENIX WORKS, PENISTONE, near SHEFFIELD.

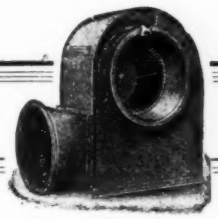
Telephone:
21 PENISTONE.

Telegrams:
"DURRANS, PENISTONE."

Manufacturers of
FOUNDRY EQUIPMENTS

LADLES,
FIRE BRICKS,
STONE FLUX,
CASTING CLEANERS,
PIPE NAILS,
SPRIGS,
WIRE BRUSHES,
BELLOWS,
CUPOLAS,
GANISTER,
LOAM AND SAND MILLS,
STUDS,
CHAPLETS,
BRUSHES,
CORE ROPES.
BUCKETS,
SPADES, Etc.

Write for Illustrated Catalogue on Blacking and Foundry Requisites, also for our latest Price List.



40 Years' Experience in the Design & Construction of Fans

for

Heating and Ventilation of Buildings, Mines and Ships,
Mechanical Boiler Draught,
Dust Removal and Collection,
High Pressure Blast for Forges, Furnaces and Cupolas,
Fume and Steam Removal,
Cooling and Drying Plants

means

Expert Knowledge, High Efficiency, Reliability & Good Service

Davidson's the TRADE SIROCCO MARK **Fan Makers**

have an experience covering hundreds of different industries and hundreds of different uses, and they can furnish a Sirocco Fan for every purpose for which a fan can be employed.

Solve your fan problems by using the Sirocco Service.

DAVIDSON & Co. LIMITED
SIROCCO ENGINEERING WORKS - BELFAST
LONDON - BIRMINGHAM - CARDIFF - BRISTOL - MANCHESTER - GLASGOW - NEWCASTLE

PIG IRON
and
High Grade
CYLINDER
IRON
For Motor Castings.

FOUNDRY & FURNACE COKE

J. C. ABBOTT & Co LTD
LLOYD'S BANK CHAMBERS, NEW STREET, BIRMINGHAM.
TELEPHONE: MIDLAND 170.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	55	10	0
Three months ..	55	16	3
Electrolytic ..	60	0	0
Tough	57	0	0
Best selected ..	58	0	0
Sheets	84	0	0
India	69	5	0
Wire bars ..	60	10	0
Do. August ..	60	0	0
Do. September ..	60	0	0
Ingot bars ...	60	0	0
H.C. wire rods ..	64	10	0
Off. av. cash, June 54	1	3 5/16	
Do. 3 mths. June 54	13	9 5/16	
Do.,Sttlmnt. June 54	1	2 3/4	
Do., Electro, June 60	1	1 1/4	
Do., B.S., June.. 58	7	6	
Aver. spot price copper, June .. 54	1	3 1/2	
Do.,wire bars, June 60	4	7 1/2	
Solid drawn tubes		12 1/4d.	
Brazed tubes ..		12 1/4d.	
Wire		9 1/2d.	

BRASS.

Solid drawn tubes ..	11 1/4d
Brazed tubes ..	13 1/4d.
Rods, drawn	10 3/4d.
Rods, extd. or rlld. ..	7 1/4d.
Sheets to 10 w.g. ..	9 3/4d.
Wire	9 1/4d.
Rolled metal ..	9 1/4d.
Yellow metal rods ..	7 1/4d.
Do. 4 × 4 Squares..	8d.
Do. 4 × 3 Sheets ..	8 1/4d.

TIN.

	£	s.	d.
Standard cash ..	286	0	0
Three months ..	280	2	6
English	283	10	0
Bars	284	15	0
Straits	292	15	0
Australian ..	293	5	0
Eastern	288	5	0
Banca	297	15	0
Off.avr.cash, June 296	2	1 3/4	
Do.,3 mths., June286	10	10	
Do., Sttlmt. June 296	1	2 3/4	
Aver. spot, June 296	2	1 3/4	

SPELTER.

	£	s.	d.
Ordinary ..	28	11	3
Remelted ..	26	0	0
Hard	22	0	0
Electro 99.9 ..	31	5	0
English	28	10	0
India	24	0	0
Zinc dust ..	37	0	0
Zinc ashes ..	10	0	0
Off. aver., June ..	28	12	1 5/16
Aver., spot, June	28	11	11 1/2

LEAD.

	£	s.	d.
Soft foreign ppt.	23	13	9
English	25	0	0
Off. average, June 24	11	10 1/2	
Average spot, June 24	8	9	

ZINC SHEET , &c.

	£	s.	d.
Zinc sheets, English 36	0	0	
Do. V.M. ex whf. 34	10	0	
Rods	42	0	0
Boiler plates ..	34	0	0
Battery plates ..	33	10	0

ANTIMONY.

	£	s.	d.
Special brands, Eng. 69	0	0	
Chinese	52	0	0
Crude	39	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver ..	21	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—			
25%	8	15	0
45/50% ..	12	10	0
75%	19	15	0
Ferro-vanadium—			
35/40% ..	14/3 lb. va.		
Ferro-molybdenum—			
70/75% c. free	5/- lb		
Ferro-titanium—			
23/25% carbonless	11 1/2d.		
Ferro-phosphorus, 20/25%,	17	15	0
Ferro-tungsten—			
80/85%, c. fr...	1/4 1/2 lb.		
Tungsten metal powder—			
98/99% ..	1/8 1/2 lb.		
Ferro-chrome			
2/4% car. ..	£33	15	0
4/6% car. ..	£23	15	0
6/8% car. ..	£23	0	0
8/10% car. ..	£22	12	6
Ferro-chrome—			
Max. 2% car.	£36	0	0
Max. 1% car.	£42	0	0
Max.0.70% car.	£54	0	0
70%, carbonless	1/5 lb.		
Nickel—99%, cubes or pellets ..	£170		
Ferro-cobalt	9/3 lb.		
Aluminium 98/99% ..	£105		
Metallic Chromium—			
96/98%	3/3 lb.		
Ferro-manganese (net)—			
76/80%, loose	£12	0	0
76/80%, packed	£13	0	0
76/80%, export	£11	15	0
Metallic manganese—			
94/96%, carbonless	1/10 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten ..	s. d. 2 6
Finished bars, 18% tungsten ..	3 0

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares 3 in. and over ..	4d. lb.
Rounds and squares under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 1/16 in.	1/- lb.
Flats, ¼ in. × ¼ in. to under 1 in. × ¾ in.	3d. lb.
Do. under ¼in. × ¼in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length 10% extra.

Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.

Per lb. net, d/d steel makers' works.

SCRAP.

	£	s.	d.
South Wales—			
Hvy. steel ..	3	2	6
Bundled steel & shrngs.	2 14 0 to 2	16	0
Mixed iron & steel	2 15 0 to 2	17	0
Heavy cast iron	3 0 0 to 3	3	6
Good machinery for foundries ..	3	5	0
Cleveland—			
Heavy steel ..	2	15	0
Steel turnings ..	2	2	6
Cast iron borings	2	1	0
Heavy forge ..	3	15	0
Bushelled scrap	3	5	0
Cast-iron scrap	3 2 6 to 3	7	6
Lancashire—			
Cast-iron scrap	3 7 6 to 3	10	0
Hvy. wrought ..	3	2	6
Steel turnings..	2	0	0

London — Merchants' buying prices delivered yard.

Copper (clean)..	47	0	0
Brass (clean) ..	38	0	0
Lead (less usual draft)	20	10	0
Tea lead ..	16	10	0
Zinc	18	0	0
New aluminium cuttings ..	82	0	0
Braziery copper	44	0	0
Gunmetal ..	47	0	0
Holiow pewter	180	0	0
Shaped black pewter ..	140	0	0

PIG-IRON

(f.o.t. unless otherwise stated).

N.E. Coast—	
Foundry No. 1 ..	72/6
Foundry No. 3 ..	70/-
Foundry No. 4 ..	69/-
Forge No. 4 ..	68/6
Hematite No. 1 ..	77/-
Hematite M/Nos. ..	76/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/-
,, d/d Birm. ..	94/-
Midlands—	
Staffs. common* ..	—
,, No. 4 forge ..	—
,, No. 3 fdry. 68/- to	70/-
Shrops. basic ..	—
,, Cold blast, ord.*	—
,, ,, roll iron*	—
* d/d Birmingham.	
Northants forge ..	—
,, fdry. No. 3 ..	62/6
Derbyshire forge ..	—
,, fdry. No. 3 ..	67/6
,, basic	—
Scotland—	
Foundry No. 1 ..	—
,, No. 3 ..	78/-
Hem. M/Nos. ..	80/-
Sheffield (d/d district)—	
Derby forge ..	71/6
,, fdry. No. 3 ..	73/6
Lincs. forge ..	—
,, fdry. No. 3 ..	78/-
E.C. hematite ..	89/-
W.C. hematite ..	92/6
Lincs. (at furnaces)—	
Forge No. 4 ..	—
Foundry No. 3 ..	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge ..	—
,, fdry. No. 3 ..	75/9
Northants foundry No. 3	—
Dalzell, No. 3	105/- to 110/-
Summerlee, No. 3	95/- to 102/-
Glengarnock,No.3	95/- to 102/-
Gartsherrie,No.3	95/- to 102/-
Monkland, No.3	95/- to 102/-
Coltness, No. 3	95/- to 102/-
Shotts, No. 3	95/- to 102/-

FINISHED IRON & STEEL.

Usual District deliveries for iron ; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars (cr.) nom.	10 10 0 to			11 0 0		
Angles	—					
Tees to 3 united ins.	—					
Nut and bolt iron	—					
Hoops	14	10	0			
Marked bars (Staffs.) f.o.t...	13	10	0			
Gas strip ..	12	10	0			
Bolts and nuts .. ¾ in. × 4 in. ..	15	5	0			
Steel—						
Ship plates	8 2 6 to			8 7 6		
Boiler plts. ..	11	0	0			
Chequer plts. ..	10	5	0			
Angles	7	12	6			
Tees	8	12	6			
Joists	7	12	6			
Rounds and squares 3 in. to 5¼ ins..	7	15	0			
Rounds under 3 in. to ¾ in. (Untested)	8	0	0			
and upwards						
Flats, over 5 in. wide and up ..	9	2	6			
Flats, 5in. to 1½in.	8	2	6			
Rails, heavy ..	8	2	6			
Fishplates ..	12	10	0			
Hoops (Staffs.) ..	10	10	0			
Black sheets, 24g.	10	12	6			
Galv. cor. shts, 24g.	14	2	6			
Galv. fencing wire 8g. plain ..	12	10	0			
Billets, soft	6 10 0 to			7 0 0		
Billets, hard ..	—					
Sheet bars ..	6	0	0			
Tin bars d/d ..	6	0	0			

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	2 1/4
Sheet to 10 w.g. ..	1	2 1/2
Wire	1	3 1/4
Rods	1	2 3/4
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free.

10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.

C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

per lb.

Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks ..	9d. to 1/5½
Ingots rolled to spoon size ..	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	21.26
No. 2 foundry, Valley	18.00
No. 2 foundry, Birm.	18.00
Basic	20.75
Bessemer	20.26
Malleable	19.76
Grey forge	19.26
Ferro-mang. 80% d/d	90.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	33.00
O.-h. billets	33.00
O.-h. sheet bars ..	33.50
Wire rods	42.00
	Cents.
Iron bars, Phila. ..	2.12
Steel bars	1.80
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel..	1.80
Skelp, sheared steel ..	1.80
Steel hoops	2.30
Sheets, black, No. 24..	3.00
Sheets, galv., No. 24..	3.85
Sheets, blue an'l'd, 9 & 10	2.25
Wire nails	2.50
Plain wire	2.40
Barbed wire, galv. ..	3.20
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry ..	—
,, furnace	—
Durham & North.	
,, foundry ..	—
,, furnace ..	15/6
Other Districts, foundry	—
,, ,, furnace (basis)	12/6

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	18/9
,,	28×20, ,,	37/6
,,	20×10, ,,	—
,,	18¾×14, ,,	—
C.W.	20×14, ,,	17/6
,,	28×20, ,,	—
,,	20×10, ,,	—
,,	18¾×14, ,,	—

Terneplates 28 × 20, — per box basis f.o.b.

SWEDISH IRON.

Bars,hammered	£18/10 to £19/0
Rolled Ord.	£15/5/0 to £15/15
Nail rods	£15 12 6 to £16 0 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£8 to £12
Pig-iron	£6 0 0 to £6 10 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.

Up to and incl. 6 in.

	Tubes.	*Fittings*
Gas	67½%	45%
Water	62½%	40%
Steam	57½%	35%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.		
July 14	53	17	6	inc.	3/9
,, 15	54	6	3	,,	8/9
,, 18	54	11	3	,,	5/–
,, 19	54	17	6	,,	6/3
,, 20	55	10	0	,,	12/6

Electrolytic Copper.

	£	s.	d.		
July 14	60	0	0	inc.	5/–
,, 15	60	0	0	No change	
,, 18	60	0	0	,,	,,
,, 19	60	0	0	,,	,,
,, 20	60	0	0	,,	,,

Standard Tin (Cash).

	£	s.	d.		
July 14	286	7	6	inc.	47/6
,, 15	290	5	0	,,	77/6
,, 18	291	5	0	,,	20/–
,, 19	285	15	0	dec.	110/–
,, 20	286	0	0	inc.	5/–

Tin (English ingots).

	£	s.	d.		
July 14	283	10	0	inc.	40/–
,, 15	287	5	0	,,	75/–
,, 18	288	10	0	,,	25/–
,, 19	282	15	0	dec.	115/–
,, 20	283	10	0	inc.	15/–

Zinc Sheets (English).

	£	s.	d.		
July 14	37	10	0	No change	
,, 15	37	10	0	,,	,,
,, 18	36	0	0	dec.	30/–
,, 19	36	0	0	No change	
,, 20	36	0	0	,,	,,

Spelter (ordinary).

	£	s.	d.		
July 14	27	17	6	inc.	2/6
,, 15	28	3	9	,,	6/3
,, 18	28	0	0	dec.	3/9
,, 19	28	5	0	inc.	5/–
,, 20	28	11	3	,,	6/3

Lead (English).

	£	s.	d.		
July 14	24	5	0	No change	
,, 15	24	10	0	inc.	5/–
,, 18	24	10	0	No change	
,, 19	24	10	0	,,	,,
,, 20	25	0	0	inc.	10/–

Exports of Iron Castings in June and the six months 1927, compared with June and the six months 1926.

	June, 1926.	June, 1927.	Six months, 1926.	Six months, 1927.	June, 1926.	June, 1927.	Six months, 1926.	Six months, 1927.
BUILDERS' CASTINGS—	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Stoves, Grates, etc., Cisterns, Baths, etc., and cooking and washing boilers—								
To Argentine Republic	58	76	661	837	1,897	2,414	25,942	30,102
,, British South Africa	300	160	2,361	1,478	10,390	6,098	79,182	53,028
,, ,, East Indies	110	114	884	905	4,490	4,659	39,224	41,621
,, Australia	47	87	466	542	2,944	6,267	26,741	30,623
,, New Zealand	108	188	1,118	1,198	5,093	9,595	56,775	60,750
,, Other countries	699	572	3,923	3,857	33,840	27,391	188,388	194,083
Total	1,322	1,197	9,483	8,817	58,654	56,424	416,252	410,207
PIPES AND FITTINGS—CAST—								
To Argentine Republic	640	618	4,643	5,529	6,433	5,444	58,148	59,383
,, British South Africa	520	372	3,738	2,789	7,288	5,379	52,850	45,390
,, ,, India	611	537	5,233	3,386	7,752	8,133	64,524	49,719
,, Straits Settlements and Malay States	649	1,299	9,862	6,419	6,578	13,572	81,977	64,895
,, Ceylon	60	253	1,234	787	714	2,689	13,641	9,470
,, Australia	180	1,251	2,548	4,882	1,951	14,081	31,952	56,239
,, Other countries	3,057	5,703	26,248	26,789	43,361	65,523	355,619	369,586
Total	5,717	10,033	53,506	50,581	74,077	114,821	658,711	654,682
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	483	363	3,446	2,462	15,409	14,912	117,254	95,117
,, Enamelled	62	60	467	363	6,807	6,591	47,826	35,888
CASTINGS, in the rough—								
Iron	130	88	834	585	3,076	3,430	23,460	22,076
Steel	17	67	400	420	596	2,182	11,269	18,919

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INFORMATION HANDBOOKS, Advice, and Cons. free; King's Patent Agency, Ltd.—B. T. KING, C.I.M.E. (Regd. Pat. Agent, G.B., U.S.A., and Can.), 146A, Queen Victoria Street, E.C.4. 40 years' refs. 'Phone: 0682 Central.

PATENTS AND DESIGNS ACTS, 1907 & 1919.

THE PROPRIETORS of British Patent No. 224941 are prepared to Sell the Patent or to Licence British Manufacturers to work thereunder. It relates to the Manufacture of Wrought Iron.—Address: B. W. & T., 112, Hatton Garden, London, E.C.1.

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